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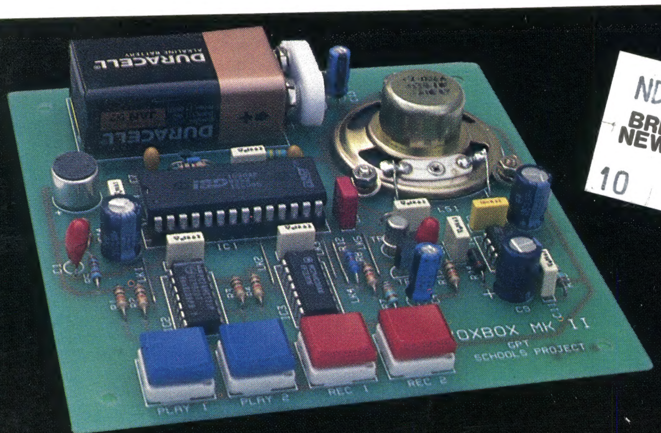

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VOXBOX

SOLID STATE VOICE RECORDING BOARD

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SIMPLE NICAD CELL CHARGER

STEREO HI-FI CONTROLLER

FREE INSIDE

GREENWELD

SUMMER SALE CATALOGUE

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THE No. 1 INDEPENDENT MAGAZINE for ELECTRONICS, TECHNOLOGY and COMPUTER PROJECTS

SEALED LEAD ACID Battery, 6v 80/100 AH made for BT, ex equipment but ok £45 each ref APR47. Ideal electric vehicle etc.

ASTEC SWITCHED MODE PSU Gives +5 @ 3.75A, +12@1.5A, -12@.4A. 230/110, cased, BM41012. £9.99 ref APR10P3.

TORRODIAL TX 30-0-30 480VA, Perfect for Mosfet amplifiers etc. 120mm dia 55mm thick. £18.99 ref APR19.

MOD WIRE Perfect for repairing PCB's, wire wrap etc. Thin insulated wire on 500m reels. Our price just £9.99 ref APR10P8.

12v MOVING LIGHT Controller. Made by Hella, 6 channels rated at 90watts each. Speed control, cased. £34.99 ref APR35.

ELACTRON FLASH TUBE As used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. £9.99 ref APR10P5.

24v 96WATT Cased power supply. New. £13.99 ref APR14.

STETHOSCOPE Fully functioning stethoscope, ideal for listening to hearts, pipes, motors etc. £6 ref MAR6P6.

OUTDOOR SOLAR PATH LIGHT Captures sunlight during the day and automatically switches on a built in lamp at dusk. Complete with seales lead acid battery etc.£19.99 ref MAR20P1.

ALARM VERSION Of above unit comes with built in alarm and pir to deter intruders. £24.99 ref MAR25P4.

CLOCKMAKER KIT Hours of fun making your own clock, complete instructions and everything you need. £7.99 ref MAR8P2.

CARETAKER VOLUMETRIC Alarm, will cover the whole of the ground floor against forcred entry. Includes mains power supply and integral battery backup. Powerful internal sounder, will take external bell if req'd. Retail £150+, ours? £49.99 ref MAR50P1.

TELEPHONE CABLE White 6 core 100m reel complete with a pack of 100 clips. Ideal 'phone extns etc. £7.99 ref MAR8P3.

VIEWDATA RETURNS £6 made by Tandata, includes 1200.75 modem, k/bd, RGB and comp o/p, printer port. No PSU.£6 MAG6P7

IBM PC CASE AND PSU Ideal base for building your own PC. Ex equipment but OK. £14.00 each **REF: MAG14P2**

SOLAR POWER LAB SPECIAL You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay or motor.Superb value kit just £5.99 REF: MAG6P8

SOLID STATE RELAYS Will switch 25A mains. Input 3.5-26v DC 57x43x21mm with terminal screws £3.99 REF MAG4P10

300DPI A4 DTP MONITOR Brand new, TTL/ECL inputs, 15" landscape, 1200x1664 pixel complete with circuit diag to help you interface with your projects. JUST £24.99. REF MAG25P1

ULTRAMINI BUG MIC 6mmx3.5mm made by AKG,.5-12v electret condenser. Cost £12 ea, Our? four for £9.99 REF MAG10P2

RGB/CGA/EGA/TTL COLOUR MONITORS 12" in good condition. Back anodised metal case. £99 each REF MAG99P1

GX4000 GAMES MACHINES returns so ok for spares or repair £9 each (no games). REF MAG9P1

C64 COMPUTERS Returns, so ok for spares etc £9 ref MAG9P2

FUSELAGE LIGHTS 3 foot by 4" panel 1/8" thick with 3 panels that glow green when a voltage is applied. Good for night lights,front panels, signs,disco etc. 50-100v per strip. £25 ref MAG25P2

ANSWER PHONES Returns with 2 faults, we give you the bits for 1 fault, you have to find the other yourself. BT Response 200's £18 ea REF MAG18P1. PSU £5 ref MAG5P12.

SWITCHED MODE PSU ex equip, 60w +5v @5A, -5v@.5A, +12v@2A,-12v@.5A 120/220v cased 245x88x55mm IECinput socket £6.99 REF MAG7P1

PLUG IN PSU 9V 200mA DC £2.99 each REF MAG3P9

PLUG IN ACORN PSU 19v AC 14w , £2.99 REF MAG3P10

POWER SUPPLY fully cased with mains and o/p leads 17v DC 900mA output. Bargain price £5.99 ref MAG6P9

ACORN ARCHIMEDES PSU +5v @ 4.4A. on/off sw uncased, selectable mains input, 145x100x45mm £7 REF MAG7P2

GEIGER COUNTER KIT Low cost professional twin tube, complete with PCB and components. £29 REF MAG29P1

SINCLAIR C5 13" wheels complete with tube, tyre and cycle style bearing £6 ea REF MAG6P10

AA NICAD PACK encapsulated pack of 8 AA nicad batteries (tagged) ex equip, 55x32x32mm. £3 a pack. REF MAG3P11

13.8V 1.9A psu cased with leads. Just £9.99 REF MAG10P3

360K 5.25 brand new half height floppy drives IBMcompatible industry standard. Just £6.99 REF MAG7P3

PPC MODEM CARDS. These are high spec plug in cards made for the Amstrad laptop computers. 2400 baud dial up unit complete with leads. Clearance price is £5 **REF: MAG5P1**

INFRA RED REMOTE CONTROLLERS Originally made for hi spec satellite equipment but perfect for all sorts of remote control projects. Our clearance price is just £2 **REF: MAG2**

TOWERS INTERNATIONAL TRANSISTOR GUIDE. A very useful book for finding equivalent transistors, leadouts, specs etc. £20 **REF: MAG20P1**

SINCLAIR C5 MOTORS We have a few left without gearboxes. These are 12v DC 3,300 rpm 6"x4", 1/4" OP shaft. £25 **REF: MAG25**

UNIVERSAL SPEED CONTROLLER KIT Designed by us for the above motor but ok for any 12v motor up to 30A. Complete with PCB etc. A heat sink may be required. £17.00 **REF: MAG17**

VIDEO SENDER UNIT. Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 100' range! (tune TV to a spare channel) 12v DC op. Price is £15 **REF: MAG15** 12v psu is £5 extra **REF: MAG5P2**

***FM CORDLESS MICROPHONE** Small hand held unit with a 500' range! 2 transmit power levels. Reqs PP3 9v battery. Tuneable to any FM receiver. Price is £15 **REF: MAG15P1**

LOW COST WALKIE TALKIES Pair of battery operated units with a range of about 200'. Ideal for garden use or as an educational toy. Price is £8 a pair **REF: MAG 8P1** 2 x PP3 req'd.

***MINATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range of up to 2 kilometres in open country. Units measure 22x52x155mm. Complete with cases and earpieces. 2xPP3 req'd. £30.00 pair **REF: MAG30** .

COMPOSITE VIDEO KIT. Converts composite video into separate H sync, V sync, and video. 12v DC. £8.00 **REF: MAG8P2.**

LQ3500 PRINTER ASSEMBLIES Made by Amstrad they are entire mechanical printer assemblies including printhead, stepper motors etc etc In fact everything bar the case and electronics, a good stripper! £5 **REF: MAG5P3** or 2 for £8 **REF: MAG8P3**

NEW BULL ELECTRICAL STORE
WOLVERHAMPTON BRANCH
NOW OPEN AT 55A WORCESTER ST TEL 0902 22039

100MHZ OSCILLOSCOPES now in stock, 12x10cm screen, delayed sweep, 1Mohm/25pf inputs, modes-ch1, ch2, add, chop, alt, dual. 460 x 305 x 200mm, 17kgs, £267+Vat includes insurance and carriage.

INFRARED LASER NIGHT SCOPES

Second generation image intensifier complete with hand grip attachment with built in laser lamp for zero light conditions. Supplied with Pentax 42mm camera mount, 1.6kg, uses 1xPP3,3xAA's(all supplied)£245+Vat

NEW HIGH POWER LASERS

15mW, Helium neon, 3 switchable wave lengths .63um,1.15um,3.39um (2 of them are infrared) 500:1 polarizer built in so good for holography. Supplied complete with mains power supply.790x65mm. Use with EXTREME CAUTION AND UNDER QUALIFIED GUIDANCE. £349+Vat.

'PC PAL' VGA TO TV CONVERTER

Just plug in and it coverts your colour television into a basic VGA screen, perfect for laptops, saves lugging monitors about or just as acheap upgrade. Intro price £49.99 +Vat.

AMSTRAD 1512DD

1512 BASE UNIT AND KEYBOARD AND TWO 5.25" 360K DRIVES . ALL YOU NEED IS A MONITOR AND POWER SUPPLY WAS £59.00

NOW ONLY **£39.00**

REF: MAG39

3FT X 1FT 10WATT SOLAR PANELS
14.5v/700mA
NOW AVAILABLE BY MAIL ORDER
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(PLUS £2.00 SPECIAL PACKAGING CHARGE)

TOP QUALITY **AMORPHOUS SILICON CELLS** HAVE ALMOST A TIMELESS LIFESPAN WITH AN INFINITE NUMBER OF POSSIBLE APPLICATIONS, SOME OF WHICH MAY BE CAR BATTERY CHARGING, FOR USE ON BOATS OR CARAVANS, OR ANYWHERE A PORTABLE 12V SUPPLY IS REQUIRED. **REF: MAG34**

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SPEAKER WIRE Brown 2 core 100 foot hank £2 REF: MAG2P1

LED PACK of 100 standard red 5m leds £5 **REF MAG5P4**

UNIVERSAL PC POWER SUPPLY complete with flyle switch, fan etc. Two types available 150w at £15 REF:MAG15P (23x23x23mm) and 200w at £20 REF: MAG20P3 (23x23x23mm)

***FM TRANSMITTER** housed in a standard working 13A adapter!! the bug runs directly off the mains so lasts forever! why pay £700? or price is £26 REF: MAG26 Transmits to any FM radio.

***FM BUG KIT** New design with PCB embedded coil for extra stability. Works to any FM radio. 9v battery req'd. £5 REF: MAG5P5

***FM BUG BUILT AND TESTED** superior design to kit. Supplied to detective agencies. 9v battery req'd. £14 REF: MAG14

TALKING COINBOX STRIPPER originally made to retail at £79 each, these units are designed to convert and ordinary phone into a payphone. The units have the locks missing and sometimes broken hinges. However they can be adapted for their original use or used for something else?? Price is just £3 **REF: MAG3P1**

100 WATT MOSFET PAIR Same spec as 2SK343 and 2SJ413 (8A, 140v, 100w) 1 N channel, 1 P channel, £3 a pair **REF: MAG3P2**

TOP QUALITY SPEAKERS Made for HI FI televisions these are 10 watt 4R Jap made 4" round with large shielded magnets. Good quality. £2 each **REF: MAG2P4** or 4 for £6 **REF: MAG6P2**

TWEETERS 2" diameter good quality tweeter 140R (ok with the above speaker) 2 for £2 **REF: MAG2P5** or 4 for £3 **REF: MAG3P4**

AT KEYBOARDS Made by Apricot these quality keyboards need just a small mod to run on any AT, they work perfectly but you will have to put up with 1 or 2 foreign keycaps! Price £6 **REF: MAG6P3**

PC CASES Again mixed types so you take a chance next one off the pile £12 **REF:MAG12** or two the same for £20 **REF: MAG20P4**

COMMODORE MICRODRIVE SYSTEM mini storage device for C64's 4 times faster than disc drives, 10 times faster than tapes. Complete unit just £12 **REF:MAG12P1**

SCHOOL STRIPPERS We have quite a few of the above units which are 'returns' as they are quite comprehensive units they could be used for other projects etc. Let us know how many you need at just 50p a unit (minimum 10).

HEADPHONES Ex Virgin Atlantic. 8 pairs for £2 **REF: MAG2P8**

PROXIMITY SENSORS These are small PCB's with what look like a source and sensor LED on one end and lots of components on the rest of the PCB. Complete with fly leads. Pack of 5 £3 **REF: MAG: 3P5** or 20 for £8 **REF: MAG8P4**

SNOOPERS EAR? Original made to clip over the earpiece of telephone to amplify the sound-it also works quite well on the cable running along the wall! Price is £5 **REF: MAG5P7**

DOS PACKS Microsoft version 3.3 or higher complete with all manuals or price just £5 **REF: MAG5P8** Worth it just for the very comprehensive manual! 5.25" only.

DOS PACK Microsoft version 5 Original software but no manuals hence only £3 **REF: MAG3P6** 5.25" only.

CTM644 COLOUR MONITOR. Made to work with the CPC464 home computer. Standard RGB input so will work with other machines. Refurbished £59.00 **REF:MAG59**

PIR DETECTOR Made by famous UK alarm manufacturer these are hi spec, long range internal units. 12v operation. Slight marks on case and unboxed (although brand new) £8 **REF: MAG8P5**

WINDUP SOLAR POWERED RADIO AM/FM radio complete with hand charger and solar panel! £14 REF: MAG14P1

COMMODORE 64 TAPE DRIVES Customer returns at £4 REF: MAG4P9 Fully tested units are £12 REF: MAG12P5.

MAINS CABLES These are 2 core standard black 2 metre mains cables fitted with a 13A plug on one end, cable the other. Ideal for projects, low cost manufacturing etc. Pack of 10 for £3 REF: MAG3P8 Pack of 100 £20 REF: MAG20P5

MICROWAVE TIMER Electronic timer with relay output suitable to make enlarger timer etc £4 REF: MAG4P4

MOBILE CAR PHONE £5.99 Well almost! complete in car phone excluding the box of electronics normally hidden under seat. Can be made to illuminate with 12v also has built in light sensor so display only illuminates when dark. Totally convincing! REF: MAG6P6

ALARM BEACONS Zenon strobe made to mount on an external bell box but could be used for caravans etc. 12v operation. Just connect up and it flashes regularly) £5 REF: MAG5P11

FIRE ALARM CONTROL PANEL High quality metal cased alarm panel 350x165x80mm.With key. Comes with electronics but no information. sale price 7.99 REF: MAG8P6

REMOTE CONTROL PCB These are receiver boards for garage door opening systems. Another use? £4 ea REF: MAG4P5

6"X12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA. Bargain price just £5.99 ea REF MAG6P12.

FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30 m for £12.99 ref MAG13P1

LOPTX Line output transformers believed to be for hi res colour monitors but useful for getting high voltages from low ones! £2 each REF: MAG2P12 bumper pack of 10 for £12 REF: MAG12P3.

BOTH SHOPS OPEN 9-5.30
SIX DAYS A WEEK

PORTABLE RADIATION DETECTOR
£49.99

A Hand held personal Gamma and X Ray detector. This unit contains two Geiger Tubes, has a 4 digit LCD display with a Piezo speaker, giving an audio visual indication. The unit detects high energy electromagnetic quanta with an energy from 30K eV to over 1.2M eV and a measuring range of 5-9999 UR/h or 10-99990 Nr/h. Supplied complete with handbook.

REF: MAG50

ISSN 0262 3617
PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .

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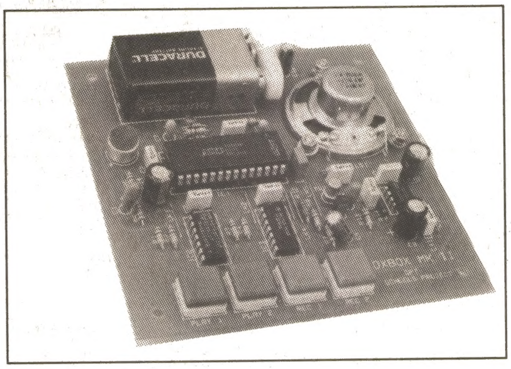
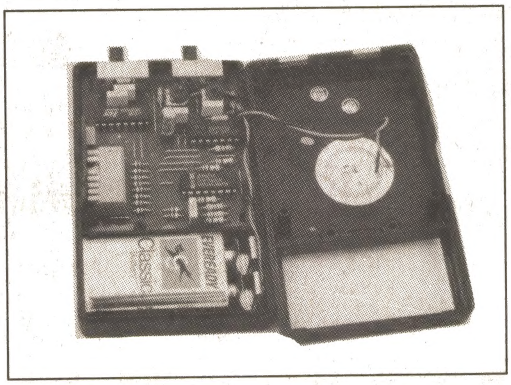
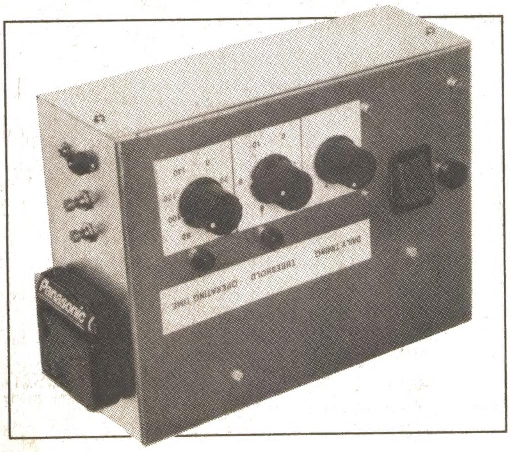
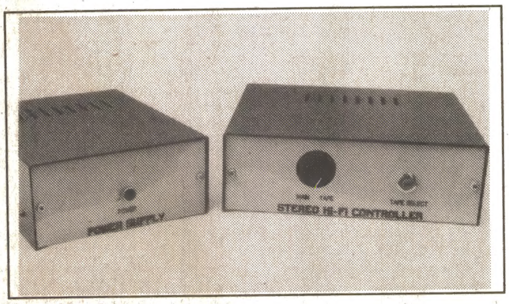
INCORPORATING ELECTRONICS MONTHLY

The No. 1 Independent Magazine for Electronics, Technology and Computer Projects









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Our August '94 Issue will be published on Friday, 1 July 1994. See page 491 for details.

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VOXBOX VOICE RECORDING BOARD 502
by Guy Dance & Jeremy Austin
Solid-state non-volatile electronic note pad – will store 20 seconds of speech

SIMPLE NiCAD CHARGER by Steve Knight 512
Keep your NiCads in top condition

WATERING WIZARD by T. R. de Vaux-Balbirnie 525
Keep your plants healthy while you are away

PRINT TIMER by Andrew Chadwick 536
A pocket print timer with independent development and fixing times

STEREO HiFi CONTROLLER – 1 by David Geary 546
Important signals take priority over background music

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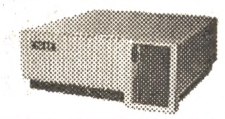


SPECIAL BUY

AT 286

40Mb HD + 3Mb Ram

LIMITED QUANTITY only of these **12Mhz HI GRADE 286** systems Made in the USA to an industrial specification, the system was designed for reliability. The compact case houses the motherboard, PSU and EGA video card with single **5¼" 1.2 Mb** floppy disk drive & **integral 40Mb hard disk** drive to the front. Real time clock with battery backup is provided as standard. Supplied in good used condition complete with **enhanced keyboard, 640k + 2Mb RAM, DOS 4.01 and 90 DAY Full Guarantee.** *Ready to Run !*

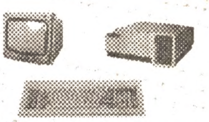
Order as HIGRADE 286 ***ONLY £169.00*** (E)

Optional Fitted extras: VGA graphics card	£29.00
1.4Mb 3½" floppy disk drive (instead of 1.2 Mb)	£32.95
NE2000 Ethernet (thick, thin or twisted) network card	£49.00

PC SCOOP

COMPLETE COLOUR SYSTEM

ONLY £99.00



A massive bulk purchase enables us to bring you a **COMPLETE ready to run** colour PC system at an unheard of price! **The Display Electronics PC99 system** comprises of fully compatible and expandable XT PC with 256k of RAM, 5¼" 360k floppy disk drive, **12" CGA colour monitor**, standard 84 key keyboard, MS DOS and all connecting cables - **just plug in and go !!** Ideal students, schools or anybody wishing to learn the world of PC's on an ultra low budget. **Don't miss this opportunity.** Fully guaranteed for 90 Days.

Order as PC99COL **£99.00** (E)

Optional Fitted extras: 640k RAM	£29.00.
2nd floppy drive, specify 5¼" 360k or 3½" 720k	£29.95.

Above prices for PC99 offer ONLY.

FLOPPY DISK DRIVES 3.5"- 8"

5.25" from £22.95 - 3.5" from £24.95

Massive purchases of standard 5.25" and 3.5" drives enables us to present prime product at industry-beating low prices! All units (unless stated) are ***BRAND NEW*** or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. **All are IBM-PC compatible** (if 3.5" supported on your PC).

3.5" **Panasonic** JU363/4 720K or equivalent	£24.95(B)
3.5" **Mitsubishi** MF355C-L. 1.4 Meg. Laptops only *	£36.95(B)
3.5" **Mitsubishi** MF355C-D. 1.4 Meg. Non laptop	£29.95(B)
5.25" **Teac** FD-55GFR 1.2 Meg	£29.95(B)
5.25" **BRAND NEW Mitsubishi** MF501B 360K	£22.95(B)

* Data cable included in price.

Shugart 800/801 8" SS refurbished & tested	£195.00(E)
Shugart 851 8" double sided refurbished & tested	£250.00(E)
Mitsubishi M2894-63 8" sided switchable *NEW*	£250.00(E)
Mitsubishi M2896-63-02U 8" DS slimline *NEW*	£285.00(E)
Dual 8" drives with 2 mbyte capacity housed in a smart case with built in power supply. Ideal as exterior drives!	£499.00(F)

HARD DISK DRIVES

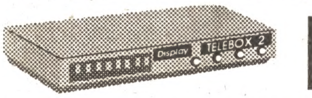
End of line purchase scoop! Brand new **NEC D2246** 8" 85 Mbyte of hard disk storage! Full **industry standard SMD interface**. Ultra hi speed data transfer and access time, replaces Fujitsu equivalent model. complete with manual. Only £299.00(E)

3.5" **FUJI** FK-309-26 20mb MFM I/F RFE	£59.95(C)
3.5" **CONNER** CP3024 20 mb IDE I/F (or equiv)RFE	£69.95(C)
3.5" **CONNER** CP3044 40mb IDE I/F (or equiv.)RFE	£99.00(C)
3.5" **RODIME** RO3085S 70mb SCSI I/F (Mac & Acorn)	£129.00(C)
5.25" **MINISCRIBE** 3425 20mb MFM I/F (or equiv.) RFE	£49.95(C)
5.25" **SEAGATE** ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5.25" **CDC** 94205-51 40mb HH MFM I/F RFE tested	£89.95(C)
8" **FUJITSU** M2322K 160Mb SMD I/F RFE tested	£195.00(E)

Hard disc controllers for MFM , IDE, SCSI, RLL etc. **from £16.95**

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



TV SOUND & VIDEO TUNER!

The **TELEBOX** consists of an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by manufacturers such as **MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD** and many more. The composite video output will also plug directly into most video recorders, allowing reception of TV channels not normally receivable on most television receivers* (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. **TELEBOX MB** covers virtually all television frequencies VHF and UHF **including the HYPERBAND as used by most cable TV operators.** A composite video output is located on the rear panel for direct connection to most makes of monitor. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

TELEBOX ST for composite video input type monitors	**£32.95**
TELEBOX STL as ST but with integral speaker	**£36.50**
TELEBOX MB Multiband VHF-UHF-Cable- Hyperband tuner	**£69.95**

For overseas PAL versions state 5.5 or 6mhz sound specification.
*For cable / hyperband reception Telebox MB should be connected to cable type socket. Shipping code on all Teleboxes is (B)

FANS & BLOWERS

MITSUBUSHI MMF-D6D12DL 60 x 25 mm 12v DC	**£4.95 10 / £42**
MITSUBUSHI MMF-09B12DH 92 x 25 mm 12v DC	**£5.95 10 / £53**
PANCAKE 12-3.5 92 x 18 mm 12v DC	**£7.95 10 / £69**
EX-EQUIP 120 x 38mm AC fans - tested specify 110 or 240 v	**£6.95**
EX-EQUIP 80 x 38mm AC fans - tested specify 110 or 240 v	**£5.95**
VERO rack mount 1U x 19" fan tray specify 110 or 240v	**£45.95**
IMHOF B26 1900 rack mnt 3U x 19" Blower 110/240v NEW	**£79.95**

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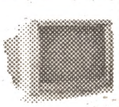
VIDEO MONITOR SPECIALS



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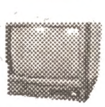

KME 10" high definition colour monitors. Nice tight 0.28" dot pitch for superb clarity and modern styling. Operates from any 15.625 khz sync RGB video source, with RGB analog and composite sync such as Atari, Commodore Amiga, Acorn Archimedes & BBC. Measures only 13.5" x 12" x 11". **Only £125** (E)
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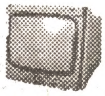

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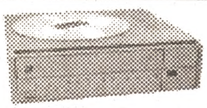

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BBC Model B type computer on a board. A major purchase allows us to offer you the **PROFESSIONAL** version of the BBC computer at a parts only price. Used as a front end graphics system on large networked systems the architecture of the BBC board has so many similarities to the regular BBC model B that we are sure that with a bit of experimentation and ingenuity many useful applications will be found for this board!! It is supplied complete with a connector panel which brings all the I/O's to 'D' and BNC type connectors - all you have to do is provide +5 and +12 v DC. The APM consists of a single PCB with most major ic's socketed. The ic's are too numerous to list but include a 6502 / 6512 CPU, RAM and an SAA5050 teletext chip. Three 27128 EPROMS contain the custom operating system on which we have no data, On application of DC power the system boots and provides diagnostic information to the video output. On board DIP switches and jumpers select the ECONET address and enable the four extra EPROM sockets for user software. Appx. dims: main board 13" x 10". I/O board 14" x 3". Supplied tested with circuit diagram, data and competition entry form.

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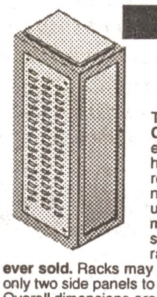

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NEXT MONTH

EXPERIMENTAL NOISE CANCELLING UNIT

Modern life undoubtedly has its advantages, but it is not without its drawbacks as well. One of these is the ever increasing amount of noise pollution. It is not surprising that there has been a lot of interest recently in devices for combating noise pollution. A number of readers have expressed an interest in electronic noise cancelling devices.

This is one of those things where it is easy to end up with a "sledgehammer to crack a nut" solution. If you simply need to cut out noise, mechanical solutions such as ear defenders, and ear plugs, are likely to be more effective than electronic solutions, and a lot cheaper. The potential advantage of an electronic noise cancelling unit is that it enables unwanted sounds to be reduced while leaving other sounds intact.

Noise cancelling systems are very simple in principle, and they use a basic phase cancelling technique. Although simple in principle phase cancelling is something less than straightforward when applied to complex sounds.

The circuits in this article will certainly provide noise cancelling, but how well (or otherwise) they function is dependent on a number of factors. These include such things as the type of sound that its to be combated, how meticulously everything is set up, and the quality of the microphones used. They provide a good basis for anyone wishing to experiment with noise cancelling techniques, p.c.b. designs are provided and the units are usable in various practical noise cancelling systems. However, this article is primarily aimed at electronics experimenters who are prepared to spend some time getting to grips with the problems involved.

6802 DEVELOPMENT BOARD

We describe the design and construction of a small microprocessor development board based around the Motorola 6802 eight bit microprocessor.

The article came about as it was perceived that there were a large number of electronics enthusiasts who would like to be able to develop applications using microprocessors but who were unable to due to the comparatively high cost of "professional" microprocessor development tools. This high cost generally precludes the use of such tools to commercial concerns. However suitable software exists as Public Domain/Shareware for the IBM PC and compatibles and the required hardware is fairly simple and hence relatively cheap as well.

DANCING FOUNTAINS

Join the musical jet set at the pool and let the fountains dance the day away.

Whilst in Jersey a couple of years ago, the author became fascinated by the dancing musical fountain display at Fort Regent. By the time he returned home, the fascination had become an obsession. He had to design a miniature version for the garden pond.

During the winter, various design ideas were tried out for a fountain display which would respond to any music from any source, indoors or out, live or recorded. Once the winter ice had melted, electronically controlled pumps and fountains were installed amongst the back-garden fish, frogs and water plants. They now enjoy the freshness of rhythmically cascading waters while the humans watch and listen as the display dances to favourite music tracks.

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Smallest room transmitter kit in the world! Incredible 10mm x 20mm including mic. 3-12V operation. 500m range.............£16.45

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Best-selling micro-miniature Room Transmitter
Just 17mm x 17mm including mic. 3-12V operation. 1000m range.............£13.45

STX High-performance Room Transmitter
Hi performance transmitter with a buffered output stage for greater stability and range. Measures 22mm x 22mm including mic. 6-12V operation, 1500m range.............£15.45

VT500 High-power Room Transmitter
Powerful 250mW output providing excellent range and performance. Size 20mm x 40mm. 9-12V operation. 3000m range.............£16.45

VXT Voice Activated Transmitter
Triggers only when sounds are detected. Very low standby current. Variable sensitivity and delay with LED indicator. Size 20mm x 67mm. 9V operation. 1000m range...£19.45

HVX400 Mains Powered Room Transmitter
Connects directly to 240V AC supply for long-term monitoring. Size 30mm x 35mm. 500m range.............£19.45

SCRX Subcarrier Scrambled Room Transmitter
Scrambled output from this transmitter cannot be monitored without the SCDM decoder connected to the receiver. Size 20mm x 67mm. 9V operation. 1000m range.............£22.95

SCLX Subcarrier Telephone Transmitter
Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range.............£23.95

SCDM Subcarrier Decoder Unit for SCRX
Connects to receiver earphone socket and provides decoded audio output to headphones. Size 32mm x 70mm. 9-12V operation.............£22.95

ATR2 Micro Size Telephone Recording Interface
Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line.............£13.45

★★★ Specials ★★★

DLTX/DLRX Radio Control Switch
Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way dil switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mm x 90mm. Both 9V operation. Range up to 200m.
Complete System (2 kits).............£50.95
Individual Transmitter DLTX.............£19.95
Individual Receiver DLRX.............£37.95

MBX-1 Hi-Fi Micro Broadcaster
Not technically a surveillance device but a great idea! Connects to the headphone output of your Hi-Fi, tape or CD and transmits Hi-Fi quality to a nearby radio. Listen to your favourite music anywhere around the house, garden, in the bath or in the garage and you don't have to put up with the DJ's choice and boring waffle. Size 27mm x 60mm. 9V operation. 250m range.............£20.95

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Smallest telephone transmitter kit available. Incredible size of 10mm x 20mm! Connects to line (anywhere) and switches on and off with phone use. All conversation transmitted. Powered from line. 500m range.............£15.95

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High performance transmitter with buffered output stage providing excellent stability and performance. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. Size 22mm x 22mm.
1500m range.............£16.45

TKX900 Signalling/Tracking Transmitter
Transmits a continous stream of audio pulses with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation.............£22.95

CD400 Pocket Bug Detector/Locator
LED and piezo bleeper pulse slowly, rate of pulse and pitch of tome increase as you approach signal. Gain control allows pinpointing of source. Size 45mm x 54mm. 9V operation.............£30.95

CD600 Professional Bug Detector/Locator
Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation.............£50.95

QTX180 Crystal Controlled Room Transmitter
Narrow band FM transmitter for the ultimate in privacy. Operates on 180 MHz and requires the use of a scanner receiver or our QRX180 kit (see catalogue). Size 20mm x 67mm. 9V operation. 1000m range.............£40.95

QLX180 Crystal Controlled Telephone Transmitter
As per QTX180 but connects to telephone line to monitor both sides of conversations. 20mm x 67mm. 9V operation. 1000m range.............£40.95

QSX180 Line Powered Crystal Controlled Phone Transmitter
As per QLX180 but draws power requirements from line. No batteries required. Size 32mm x 37mm. Range 500m.............£35.95

QRX180 Crystal Controlled FM Receiver
For monitoring any of the 'Q' range transmitters. High sensitivity unit. All RF section supplied as a pre-built and aligned module ready to connect on board so no difficulty setting up. Outpt to headphones. 60mm x 75mm. 9V operation.............£60.95

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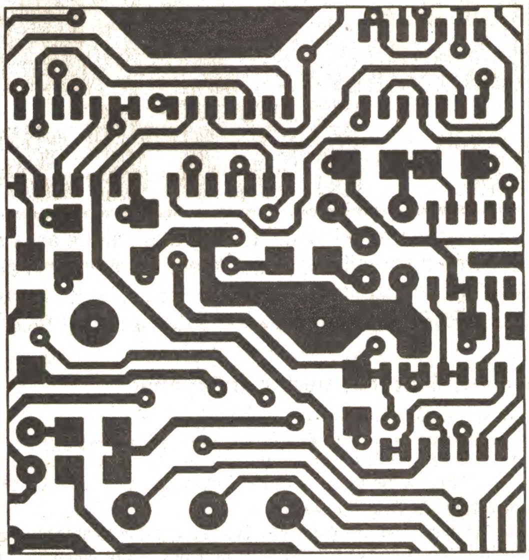

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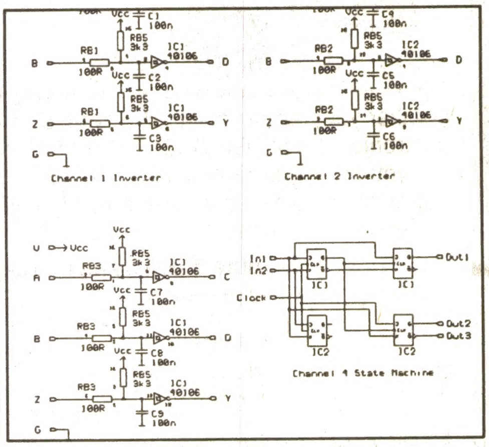

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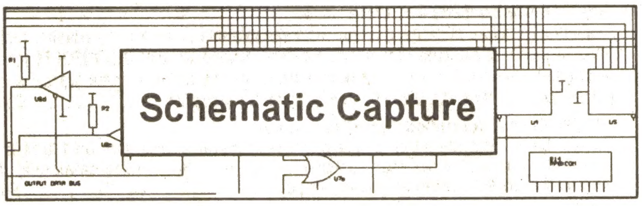
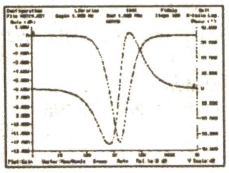


Schematic Capture



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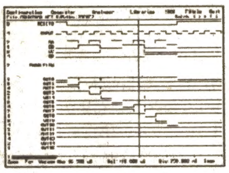

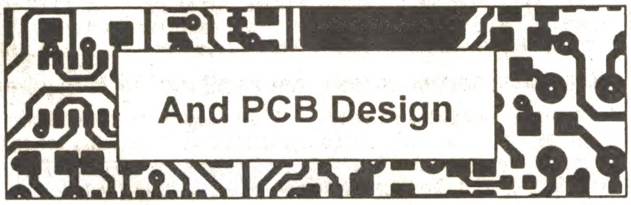

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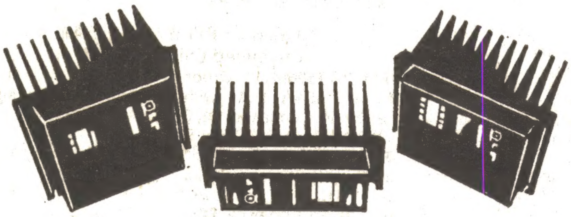

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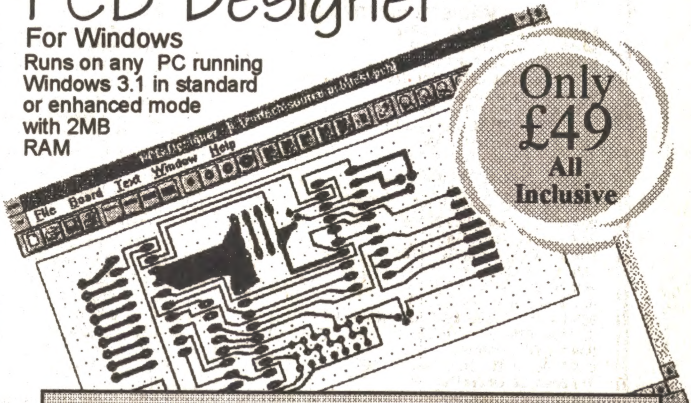

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⅛HP 12V D.C. Motor, Smiths, **£6,** Order Ref: 6P1.
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150r.p.m. 60W, £5, Order Ref: 5P169.
200r.p.m. 60W, £5, Order Ref: 5P216.
500W Motor with gearbox & variable speed selection, 100r.p.m. upwards, **£5,** Order Ref: 5P220.
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1 Rev Per 12hrs 2W Motor. £1, Order Ref: 90.
1 Rev Per 4hrs 2W Motor, £1, Order Ref: 2P239.
1 Rev Per Hour 2W Extra Small Motor, 2 for **£1,** Order Ref: 500.
12r.p.h. Motor, £2, Order Ref: 2P342.
20r.p.h. Motor, £1, Order Ref: 1010.
⅓r.p.m. 2W Motor, £2, Order Ref: 2P346.
1r.p.m. Motor, £2, Order Ref: 2P328.
4r.p.m. 2W Motor, £1, Order Ref: 446.
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8V 1A, **£1,** Order Ref: 212.
9V ½A, 2 for **£1,** Order Ref: 266.
9V 1A, **£1,** Order Ref: 236.
10V 1A, **£1,** Order Ref: 492.
12V ½A, 2 for **£1,** Order Ref: 10.
12V 1A, **£1,** Order Ref: 436.
12V 2A, **£2,** Order Ref: 2P337.
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17V 1A, **£1,** Order Ref: 492.
18V ½A, **£1,** Order Ref: 491.
20V 4A, **£3,** Order Ref: 3P106.
24V ½A, **£1,** Order Ref: 337.
30V 2½A, **£4,** Order Ref: 4P24.
36V 3A, **£3,** Order Ref: 3P14.
40V 2A, **£3,** Order Ref: 3P107.
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50V 15A, **£20,** Order Ref: 20P2.
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3kV 3mA, **£7,** Order Ref: 7P7.
4kV 2mA, **£5,** Order Ref: 5P139.
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12-0-12V 2V 3VA, **£1,** Order Ref: 636.
12-0-12V 6VA, **£1,** Order Ref: 811.
15-0-15V 1VA, **£1,** Order Ref: 937.
15-0-15V 15VA, **£2,** Order Ref: 2P68.
18-0-18V 10VA, **£1,** Order Ref: 813.
20-0-20V 10VA, **£1,** Order Ref: 812.
20-0-20V 10VA, **£2,** Order Ref: 2P85.
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20-0-20V 80VA, **£4,** Order Ref: 4P36.
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90-0-90V 100VA, **£4,** Order Ref: 4P39.

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15VA gives 1V, 7V, 8V, 9V or 10V, **£1,** Order Ref: 744.
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38V-0-38V 150VA with regulator winding, **£10,** Order Ref: 10P36.
250V-0-250V 60mA with 6·3V 5A additional winding made for valve circuits, **£5,** Order Ref: 5P167.
230V-115V auto transformer 100VA, **£2,** Order Ref: 2P6.
Ditto but 10VA, **£1,** Order Ref: 822.
Ditto but 150VA, **£3,** Order Ref: 3P142.
Ditto but 1kVA, **£20,** Order Ref: 20P.

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230V-230V 10VA, £1, Order Ref: 821.
230V-230V 150VA, **£7.50,** Order Ref: 7.5P.
230V-230V with adjustable tappings 250VA, **£10,** Order Ref: 10P97.
440V-240V 100VA, **£10,** Order Ref: 10P115.

BARGAINS NOT PREVIOUSLY ADVERTISED

Speed Controller for 12V D.C. Motors. Suitable for the C5 and other D.C. motors with horsepowers up to one-third. Gives very good control to speed. Uses MOSFETS and is based upon a circuit given in the *Model Engineer* some time ago. Complete kit with case and separate motor reversing switch, **£18,** Order Ref: 18P8.

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Fig-8 Flex. Fig-8 flat white pvc, flexible with 0·4 sq. mm cores. Ideal for speaker extensions and bell circuits. Also adequately insulated for mains lighting. 50m coil **£2,** Order Ref: 2P345, 12m coil **£1,** Order Ref: 1014.

Friedland Underdome Bell. Their ref. 792, a loud ringer but very neat, 3" diameter, complete with wall fixing screws, **£4,** Order Ref: 4P75.

A very slow Geared Motor. Does just one rev. in five minutes, very good make (Crouzet), mains operated, **£3,** Order Ref: 3P175.

High Voltage Caps. Ideal if you are making laser power supplies or ionizers, p.c.b. mounting, 2000V working, 12NF + or − 5%. 4 for **£1,** Order Ref: 1007. Quantity price 15p each + VAT for 350 lots.

Powerful Waterproof Speaker. 3½" diameter, 8 ohm, 12W. Can be completely submerged, only **£1.50,** Order Ref: 1.5P27.

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12V 10A Switch Mode Power Supply. For only **£9.50** and a little bit of work because you have to convert our 135W PSU. Modifications are relatively simple – we supply instructions. Simply order PSU Ref: 9.5P3 and request modification details, price still **£9.50.**

Its Lawn Mowing Time. We can still supply a very flexible 2-core cable ideal for Black and Decker and similar tools and at only 10p a meter. Minimum 20m for **£2,** Order Ref: 2P20.

WHEN YOU ORDER THIS MONTH
You will receive our current newsletter and two lists giving details of well over 1,000 of our special bargains.

Field Telephone Bargain. You can have a really modern field telephone. Ex-British Telecom but refurbished, almost as new. Original cost over £100 each, yours for only **£15,** Order Ref: 15P52. These normally work in pairs and require only PP3 batteries to call each other. We still have a few of the old field telephones and you can have them at a very low price, only **£8.50** but you will have to make your own handle to wind the ringing generator.

Are you Making a Mini Bug? We can offer the ideal box. White plastic without any decoration or printing. This has an on/off switch in the top left-hand corner and a hole just above to take telescopics or wire aerial. The case is large enough to take a PP3 battery and a p.c.b. and when finished it will have a really professional look. Box with switch **£1,** Order Ref: 1006, size approx. 4" × 3" × 1½" thick.

Making Ionisers or Other High Voltage Devices? We have big stocks of 1, 1½ and 2kV caps. Mostly tubular but some oblong p.c.b. mounting types. In small quantities **25p** including VAT? in 500's or more **15p** + VAT.

Battery Operated Solenoid. Will work on 4½V but is best at 6V. Quite compact, only 35mm long and 14mm square. Has a very good pull, 2 for **£1,** Order Ref: 1012.

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Another Remarkable Low Priced Offer. Our burglar alarm, Order Ref: 10P76. This is ultrasonic and is a complete transmitter and receiver. The transmission is reflected back by a person or object and it triggers the alarm, which can be noiseless or very noisy, as you wish. These were originally made to sell at over **£40** each but if you just want one the price is **£10** or a box of 12 for **£100.**

Twin Cassette Mechanism. We have just acquired a large quantity of these, all brand new and intended to be incorporated in a midi system. It is a complete twin cassette mechanism with all the controls and tape counter. Only **£2,** Order Ref: 2P351.

Unusual Motorised Pump. Mains operated, the motor is coupled to a small bellows pump, to which flex tubes can be connected. Won't give a big flow but it will lift and can develop quite a pressure. Price **£4,** Order Ref: 4P77.

Solenoid Valve. Is mains operated but the flow stops when it is switched on, price **£3,** Order Ref: 3P178.

POWER SUPPLIES – SWITCH MODE

(all 230V mains operated)

Astec Ref. B51052 with outputs: +12V 0·5A; −12V 0·1A; +5V 3A; +10V 0·05A; +5V 0·02A unboxed on p.c.b. size 180 x 130mm, **£5,** Order Ref: 5P188.
Astec Ref. BM41004 with outputs: +5V 3½A; +12V 1·3A; −12V 0·2A; **£5,** Order Ref: 5P199.
Astec No. 12530 +12V 1A; −12V 0·1A; +5V 3A; uncased on p.c.b. size 160 x 100mm, **£3,** Order Ref: 3P141.
Astec No. BM41001 110W 38V 2·5A; 25·1V 3A part metal cased with instrument type main input socket and on/off d.p. rocker switch, size 354 x 118 x 84mm, **£8.50,** Order Ref: 8.5P2.
Astec Model No. BM135-3302 +12V 4A; +5V 16A; −12V 0·5A, totally encased in plated steel with mains input plug, mains output socket and double-pole on/off switch, size 400 x 130 x 65mm, **£9.50,** Order Ref: 9.5P4.

POWER SUPPLIES – LINEAR

(all cased unless stated)

4·5V DC 150mA, £1, Order Ref: 104.
5V DC 2½A PSU with filtering and voltage regulation, uncased, **£4,** Order Ref: 4P63.
6V DC 700mA, £1, Order Ref: 103.
6V DC 200mA output in 13A case, **£2,** Order Ref: 2P112.
6-12V DC for models with switch to vary voltage and reverse polarity, **£2,** Order Ref: 2P3.
9V DC 150mA, £1, Order Ref: 762.
9V DC 2·1A by Sinclair, **£3,** Order Ref: 3P151.
9V DC 100mA, £1, Order Ref: 733.
12V DC 200mA output in 13A case, **£2,** Order Ref: 2P114.
12V 500mA on 13A base, **£2.50,** Order Ref: 2.5P4.
12V DC 1A filtered and regulated on p.c.b. with relays and piezo sounder, uncased, **£3,** Order Ref: 3P80.
Amstrad 13·5V DC at 1·8A or 12V DC at 2A, **£6,** Order Ref: 6P23.
24V DC at 200mA twice for stereo amplifiers, **£2,** Order Ref: 2P4.
9·5V 60mA A.C. made for BT, **£1.50,** Order Ref: 1.5P7.
15V 320mA A.C. on 13A base, **£2,** Order Ref: 2P281.
AC out 9·8V at 60mA and 15·3V at 150mA, £1, Order Ref: 751.
BT power supply unit 206AS, charges 12V battery and cuts off output should voltage fall below pre-set, **£16,** Order Ref: 16P6.
Sinclair Microvision P.S.U., £5, Order Ref: 5P148.

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2mW Laser, Helium Neon by Philips, full spec. **£30,** Order Ref: 30P1.
Power supply for this in kit form with case is **£15,** Order Ref: 15P16, or in larger case to house tube as well, **£18,00,** Order Ref: 18P2.
The larger unit, made up, tested and ready to use, complete with laser tube, **£69,** Order Ref: 69P1.

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100mA solar cell, **£1,** Order Ref: 631.
400mA solar cell, **£2,** Order Ref: 2P119.
700mA solar cell, **£3,** Order Ref: 3P42.
1A solar cell, **£3.50,** Order Ref: 3.5P2.
3V 200mA solar cell, **£2,** Order Ref: 2P324.
15V 200mA solar cell, **£15,** Order Ref: 15P47.
Solar Education Kit with parts to make solar fan, **£8,** Order Ref: 8P42.
Solar kits – make vintage gramophone, **£7.50,** Order Ref: 7.5P3.
Make Helicopter, £7.50, Order Ref: 7.5P17.
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MB1	79	61	40	£1.35
MB2	100	76	41	£1.47
MB3	118	98	45	£1.71
MB4	216	130	85	£5.19
MB5	150	100	60	£2.35
MB6	220	150	64	£3.95
MB 7	177	120	83	£3.42
MB8	150	80	50	£2.22

All sizes are in millimetres

METAL CLAD HIGH WATTAGE WIREWOUND RESISTORS
0·12 Ohm 5W 30p each
0·10 Ohm 25W 80p each
1·00 Ohm 50W £1.00 each
2·20 Ohm 50W £1.00 each
3·9 Ohm 50W £1.00 each
10·00 Ohm 100W £2.00 each
2·2 kOhm 50W £1.00 each

MICRO SWITCH roller arm operation spdt 40p each

MINIATURE TOGGLE SWITCHES

spdt	60p each	spdt 3 position c/off	70p each
dpdt	70p each	dpdt 3 position c/off	80p each
spdt biased	60p each	spdt 3 position c/off biased both ways	70p each
		dpdt 3 position c/off biased one way	80p each

MOSFET
RFM70N60
70A 50V 250W
£4.11 each

MINIATURE PUSH TO MAKE SWITCH 50p each
DIL RELAYS 5 volt dp/changeover 60p 10 for £5.00
12 volt dp/changeover 80p 10 for £6.00
RELAY 10 amp contacts sp/changeover 12 volt coil £1.20 each
CAR HORN RELAY in metal can with fixing lug, s/pole on 10 amp contacts £1.00 each 6 for £5.00
20 AMP RELAY dp on 12 volt coil £1.50 each 4 for £5.00
REED RELAY 12 volt 50p each 10 for £4.00
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	plug	socket	cover
9 pin	30p	30p	35p
15 pin	40p	40p	35p
25 pin	50p	50p	40p

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1 amp 7805/7812/7815 all 33p each. 7905/7912/7915 all 39p each
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100mA 78L05/78412/78L15 all 26p each. 79L05/79L12/79L15 all 29p each
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2N3053 29p each, 2N3055 70p each, 2N4403 28p each, 2N3819 40p each
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SPECIAL OFFER PROJECT BOX
In white
high impact ABS
50 x 70 x 25mm
60p each 10 for **£5.00**

OPTO DEVICES – LEDS – ETC

5mm rnd red/yellow/green/amber	10p each 12 for £1.00 any mix
5mm rnd high brightness red/green	20p each 6 for £1.00 any mix
5mm rnd flashing	red 60p each, yellow/green 70p each
5mm rnd bi-colour	35p each, tri-colour 45p each
LED mounted in chrome bezel red, yellow or green	30p each, 4 for £1
LED mounted in a black bezel red only	25p each, 5 for £1.00
PLASTIC BEZEL for 5mm rnd leds	10 for 40p
High brightness bi-colour l.e.d., rectangular, red/green, two leads	40p each

TEMPERATURE PROBE

High quality probe made for the medical profession. Consists of a resistive sensor mounted in a plastic covered probe with a 1 meter curled lead. Temp. range −40 to 150°C. Resistance at: 150°C 188.3 ohms; −40°C 336.5 kohm; 25°C 10.0 kohm ± 70 ohms. The original price of these probes was over £24.00. Full data supplied. **OUR PRICE £3.76**

RESET TIMER PCB

Gives a timed relay closure following a momentary input. Requires 12V d.c. supply SP c/o relay output LED indication. 19 different time intervals from 25sec to 35min 20sec. £5.98 each.

UNIVERSAL BELL TIMER

10 or 20 minute bell cut off +ve or −ve trigger* timed relay contacts. £4.96

ALARM CONTROL UNIT

Single zone alarm control unit built into a domestic light switch box. Ideal for home, caravan, boat, garage, shed etc.

Facilities: – Normally closed loop for pir sensors, door/window contacts etc. Normally open loop for pressure mats. 24-hour loop for personal attack button Visual indication that the system is operational. Automatic entry/exit delay. Automatic system reset. Alarm output cmos logic level.

SIREN
12 volt dc for external use 115db £8.95

PRICE COMPLETE WITH FULL INSTRUCTIONS £8.95

SUB-MINIATURE PASSIVE INFRA-RED SENSOR ONLY £7.95
Brand new passive infra-red sensor, measures only 33mmW x 24mmH x 29mmD. Logic level output. Full data and application notes supplied.

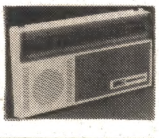
EX INSTALLATION SENSORS tested working.
Type 1. Measures 180 x 112 x 70mm with walk test led, relay output and tamper protection. 12 volt dc supply required £8.50 each
Type 2. As above but a smaller unit 123 x 62 x 50mm £11.75 each
Type 3. Ceiling mounting passive, infra red sensor 360° detection, 12V d.c. supply relay output, tamper circuit and pulse count option. Data supplied. £15.70 each

Please note: There may be variations in the size of the above passive infra red sensors depending on stock at the time of ordering. But the unit will certainly be within the stated sizes.

DOOR/WINDOW CONTACTS
Surface or flush mounting, white £1.10 each
JUNCTION BOX
white 6 way 60p

DUAL TECH SENSOR Microwave and passive infra-red combined. Separate led indication for each function. Measures 120 x 75 x 50mm. 12 volt d.c. supply, Relay output. Tamper protection. £29.95 each

ALARM CONTROL PANEL ST3000



Wire free alarm control panel, detectors communicate with the panel by means of radio transmitters. Speech synthesis for programming and general operating guidance*. Built in user programmable telephone dialler*. Up to 32 transmitters can be be used*. Programmable exit/entry and bell timers*. Programmable user codes.* Full installation data supplied, the only thing that has to be handwired is the output to the siren/bell unit (not supplied)*. These control panels cost over £300.00. Yours for only £59.95.
Suitable **PASSIVE INFRA SENSOR/TX £25.85**
Battery operated, available in 8m range, 10m range or 25m range.

UNIVERSAL TX

For connection of normally open or closed contacts e.g. door/window switches, pressure mats etc. £17.63

BULK LEDS OFFER
500 5mm round
RED LEDS £25.85

BREADBOARDS – CAPACITORS – SOLAR CELLS – HEATSHRINK – ETC

SOLAR CELL 2 volt 150mA max, size 60 x 100mm £1.35 each 5 for £6
BNC SOCKETS 50 ohm single hole fixing 50p each 10 for £4.00

MERCURY TILT SWITCH
Standard on/off £1.00 each
4 Contact (Directional) £1.50 each
PIEZO VIBRATION SENSOR
with data sheet £1.00 each

BREADBOARD
173 X 65mm 840TP £5.25 each
TEXTOOL ZIF SOCKET
28 pin zero insertion socket £5.95 each

CAPACITOR 10,000 mfd 25 volt with fixing clip 60p each
EPROMS 27C256 – 30 27C512 – 25. Once programmed but never used eprom. Mounted on a plastic carrier, can easily be removed from the carrier or used with a low insertion force socket.
27C256 £1.00 each 6 for £5.00 **27C512** £1.20 each 5 for £5.00
Suitable low insertion force socket 28 pin 40p each 3 for £1.00
MULTITURN PRESETS 20mm RECT, 1K, 5K, 10K, 20K, 50K, 100K 1MO. 40p each, 3 for £1.00

100db PIEZO SOUNDER
2KHz note, 3-12V d.c. 40Ma, 45mm dia. x 26mm £1.76 each
SOUND BOMB Two tone alarm sounder incorporating four piezo elements in white plastic box. 100db 12V D.C. £5.99
MINIATURE HORN SIREN 100db two-tone Piezo siren 12V D.C. £5.17
VIBRATION SENSITIVE ALARM BOARD WITH PIEZO SOUNDER
Originally a bike alarm. There is a short delay after activation then the piezo sounder operates for a preset period. £3.76 each
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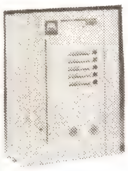
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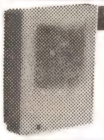

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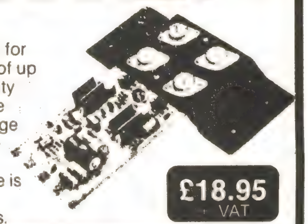

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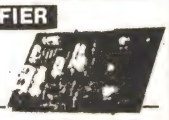

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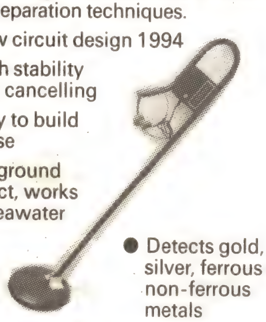

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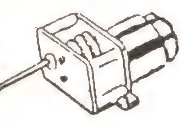

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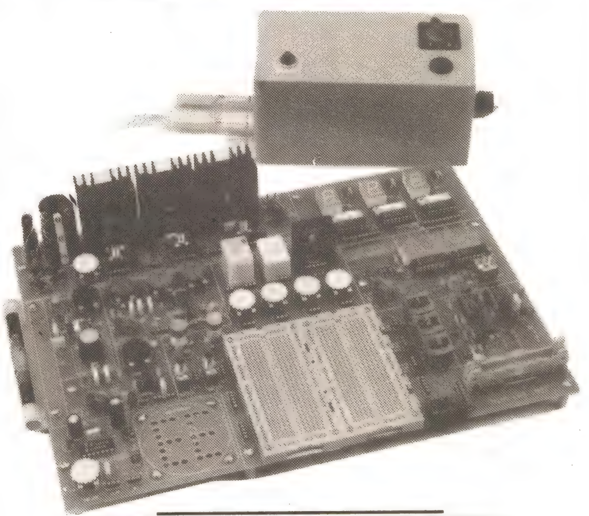

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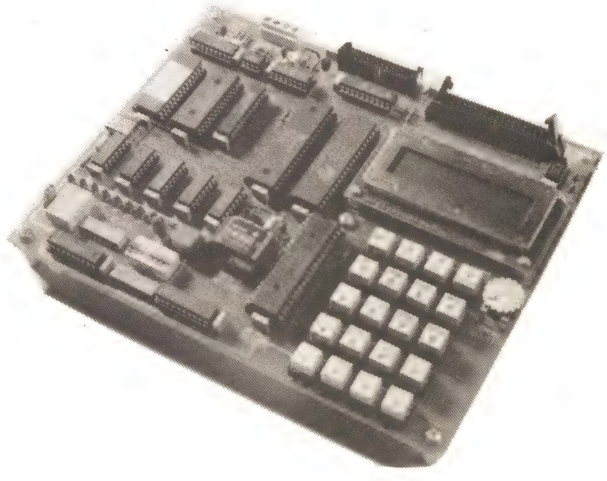

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4019	**£0.19**
4020	**£0.31**
4021	**£0.31**
4022	**£0.32**
4023	**£0.16**
4024	**£0.21**
4025	**£0.15**
4026	**£0.59**
4027	**£0.18**
4028	**£0.22**
4029	**£0.36**
4030	**£0.17**
4031	**£0.70**
4033	**£0.56**
4034	**£1.24**
4035	**£0.31**
4040	**£0.29**
4041	**£0.31**
4042	**£0.22**
4043	**£0.28**
4044	**£0.35**
4046	**£0.31**
4047	**£0.25**
4048	**£0.31**
4049	**£0.22**
4050	**£0.20**
4051	**£0.36**
4052	**£0.25**
4053	**£0.40**
4054	**£0.56**
4055	**£0.34**
4060	**£0.48**
4063	**£0.29**
4066	**£0.24**
4067	**£1.96**
4068	**£0.16**
4069	**£0.20**
4070	**£0.17**
4071	**£0.20**
4072	**£0.17**
4073	**£0.17**
4075	**£0.17**
4076	**£0.30**
4077	**£0.17**
4081	**£0.14**
4082	**£0.21**
4085	**£0.28**
4086	**£0.26**
4089	**£0.55**
4093	**£0.18**
4094	**£0.31**
4095	**£0.56**
4097	**£1.20**
4098	**£0.48**
4099	**£0.38**
4502	**£0.38**
4503	**£0.40**
4508	**£0.90**
4510	**£0.26**
4511	**£0.32**
4512	**£0.32**
4514	**£0.77**
4515	**£0.98**
4516	**£0.31**
4518	**£0.27**
4520	**£0.26**
4521	**£0.62**
4526	**£0.40**
4527	**£0.40**
4528	**£0.40**
4529	**£0.44**
4532	**£0.32**
4534	**£2.48**
4536	**£1.00**
4538	**£0.37**
4541	**£0.33**
4543	**£0.46**
4555	**£0.34**
4556	**£0.40**
4560	**£1.18**
4566	**£1.96**
4572	**£0.25**
4584	**£0.24**
4585	**£0.32**
4724	**£0.70**
40106	**£0.31**
40109	**£0.50**
40163	**£0.46**
40174	**£0.34**
40175	**£0.36**
40193	**£0.60**

OPTO DEVICES

5mm Red LED	**£0.09**
5mm Green LED	**£0.10**
5mm Yellow LED	**£0.10**
5mm Orange LED	**£0.10**
3mm Red LED	**£0.08**
3mm Green LED	**£0.12**
3mm Yellow LED	**£0.13**
3mm Orange LED	**£0.13**
5mm Flashing Red	**£0.50**
5mm Flashing Green	**£0.54**
5mm Bi Colour	**£0.36**
5mm Tri Colour	**£0.48**
5mm Plastic Bezel	**£0.04**
3mm Plastic Bezel	**£0.05**
0.3" 7 Segment Display Red	
common anode	**£1.14**
common cathode	**£1.14**

TRANSISTORS

2N1613	**£0.31**
2N1711	**£0.26**
2N1893	**£0.29**
2N2218A	**£0.28**
2N2219A	**£0.25**
2N2222A	**£0.18**
2N2646	**£0.80**
2N2904A	**£0.25**
2N2905A	**£0.23**
2N2907	**£0.20**
2N2926	**£0.16**
2N3053	**£0.27**
2N3054	**£0.90**
2N3055	**£0.62**
2N3440	**£0.50**
2N3702	**£0.09**
2N3703	**£0.10**
2N3704	**£0.10**
2N3705	**£0.10**
2N3706	**£0.10**
2N3771	**£1.44**
2N3772	**£1.51**
2N3773	**£1.79**
2N3819	**£0.40**
2N3820	**£0.66**
2N3904	**£0.10**
2N3905	**£0.10**
2N3906	**£0.10**
2N4036	**£0.31**
2N5296	**£0.57**
2N5321	**£0.57**
2N6107	**£0.60**
AC126	**£0.30**
AC127	**£0.30**
AC128	**£0.28**
AC187	**£0.45**
AC188	**£0.37**
ACY17	**£3.84**
AD149	**£1.67**
AD161	**£0.92**
AD162	**£0.92**
BC107	**£0.14**
BC107B	**£0.15**
BC108	**£0.13**
BC108A	**£0.14**
BC108C	**£0.16**
BC109	**£0.17**
BC109C	**£0.17**
BC114	**£0.41**
BC115	**£0.41**
BC116	**£0.41**
BC118	**£0.41**
BC132	**£0.36**
BC134	**£0.36**
BC135	**£0.36**
BC140	**£0.25**
BC141	**£0.27**
BC142	**£0.31**
BC143	**£0.34**
BC149	**£0.21**
BC154	**£0.36**
BC157	**£0.12**
BC159	**£0.12**
BC160	**£0.28**
BC170	**£0.16**
BC170B	**£0.16**
BC171	**£0.11**
BC171B	**£0.16**
BC172	**£0.13**
BC172B	**£0.13**
BC177	**£0.18**
BC178	**£0.18**
BC179	**£0.17**
BC182	**£0.08**
BC182L	**£0.08**
BC182LB	**£0.08**
BC183	**£0.08**
BC183L	**£0.08**
BC183LB	**£0.08**
BC184	**£0.08**
BC184L	**£0.08**

BC186	**£0.33**
BC204C	**£0.72**
BC206B	**£0.72**
BC207C	**£0.72**
BC208	**£0.72**
BC209A	**£0.72**
BC212	**£0.08**
BC212L	**£0.08**
BC212LB	**£0.08**
BC213	**£0.08**
BC213LC	**£0.08**
BC214	**£0.08**
BC214L	**£0.08**
BC237B	**£0.09**
BC238C	**£0.09**
BC239C	**£0.10**
BC251	**£0.13**
BC252	**£0.13**
BC261B	**£0.24**
BC262B	**£0.24**
BC267B	**£0.30**
BC307	**£0.10**
BC308	**£0.10**
BC327	**£0.10**
BC328	**£0.10**
BC337	**£0.10**
BC338	**£0.10**
BC414C	**£0.13**
BC441	**£0.40**
BC461	**£0.40**
BC463	**£0.29**
BC478	**£0.32**
BC479	**£0.32**
BC490	**£0.24**
BC516	**£0.22**
BC517	**£0.20**
BC527	**£0.20**
BC528	**£0.20**
BC537	**£0.20**
BC546C	**£0.08**
BC547C	**£0.09**
BC548C	**£0.08**
BC549C	**£0,10**
BC550C	**£0.10**
BC556A	**£0.08**
BC557C	**£0.08**
BC558C	**£0.08**
BC559C	**£0.08**
BC560B	**£0.09**
BC637	**£0.21**
BC638	**£0.21**
BC639	**£0.21**
BC640	**£0.21**
BCY70	**£0.21**
BCY71	**£0.20**
BCY72	**£0.20**
BD135	**£0.20**
BD136	**£0.21**
BD137	**£0.23**
BD138	**£0.22**
BD139	**£0.23**
BD140	**£0.24**
BD150C	**£0,82**
BD165	**£0.42**
BD166	**£0.35**
BD187	**£0.39**
BD201	**£0.40**
BD202	**£0.40**
BD203	**£0.40**
BD204	**£0.40**
BD222	**£0.40**
BD225	**£0.42**
BD232	**£0.38**
BD237	**£0.32**
BD238	**£0.32**
BD240B	**£0.37**
BD243B	**£0.50**
BD244A	**£0.53**
BD246	**£1.06**
BD441	**£0.41**
BD442	**£0.41**

BD534	**£0.47**
BD535	**£0.50**
BD536	**£0.65**
BD646	**£0.52**
BD648	**£0.52**
BD650	**£0.53**
BD707	**£0.42**
BD807	**£0.80**
BDX32	**£1.78**
BDX33C	**£0.49**
BDX34C	**£0.50**
BDX53C	**£0.47**
BDX54C	**£0.50**
BF180	**£0.31**
BF182	**£0.31**
BF185	**£0.31**
BF194	**£0.19**
BF195	**£0.19**
BF244	**£0.35**
BF257	**£0.33**
BF259	**£0.33**
BF337	**£0.36**
BF355	**£0.38**
BF423	**£0.13**
BF451	**£0.19**
BF459	**£0.29**
BF469	**£0.36**
BFX29	**£0.29**
BFX84	**£0.31**
BFX85	**£0.32**
BFY50	**£0.29**
BFY51	**£0.26**
BFY52	**£0.28**
BS107	**£0.21**
BS170	**£0.21**
BSW66	**£1.35**
BU126	**£1.70**
BU205	**£1.82**
BU208A	**£1.24**
BU326A	**£1.80**
BU500	**£1.54**
BU508A	**£1.76**
BU526	**£2.24**
BU806	**£1.36**
BUX84	**£0.78**
IRF540	**£1.60**
IRF740	**£1.63**
MJ11015	**£2.11**
MJ11016	**£2.11**
MJ2501	**£1.60**
MJ3001	**£1.80**
MJE340	**£0.40**
MJE350	**£0.42**
MPSA13	**£0.12**
MPSA42	**£0.17**
MRF475	**£7.28**
TIP121	**£0.35**
TIP122	**£0.37**
TIP125	**£0.37**
TIP127	**£0.40**
TIP132	**£0.46**
TIP137	**£0.46**
TIP142	**£1.08**
TIP147	**£1.12**
TIP2955	**£0.63**
TIP29C	**£0.31**
TIP3055	**£0.63**
TIP30C	**£0.31**
TIP31C	**£0.34**
TIP32C	**£0.32**
TIP33C	**£0.72**
TIP41A	**£0.36**
TIP42C	**£0.38**
TIP47	**£0.48**
TIP48	**£0.62**
TIP50	**£0.53**
VN10KM	**£0.44**
VN66AF	**£1.50**
ZTX300	**£0.16**
ZTX500	**£0.16**

TRIACS

Z0105DA	**£0.42**
TIC206D	**£0.65**
TIC226D	**£0.73**
BTA08-600B	**£0.84**
TIC236D	**£0.96**
DIAC	**£0.20**

VOLTAGE REGULATORS

78L05	**£0.24**
78L12	**£0.24**
78L15	**£0.24**
79L05	**£0.28**
79L12	**£0.28**
79L15	**£0.28**
7805	**£0.44**
7812	**£0.28**
7815	**£0.28**
7905	**£0.38**
7912	**£0.38**
7915	**£0.38**
LM317T	**£0.56**
LM723	**£0.29**
L200CV	**£1.16**
LM323K	**£2.70**
LM338K	**£5.52**

BRIDGE RECTIFIERS

W005 1.5A 50V	**£0.19**
WO2 1.5A 200V	**£0.20**
BR32 3A 200V	**£0.36**
BR62 6A 200V	**£0.64**
1004 10A 400V	**£1.39**

HARDWARE

T2 Box 75 x 56 x 25mm	**£0.82**
T3 Box 75 x 51 x 25mm	**£0.82**
T4 Box 111 x 57 x 22mm	**£0.98**
MB1 Box 79 x 61 x 40mm	**£1.44**
MB2 Box 100 x 76 x 41mm	**£1.56**
MB3 Box 118 x 98 x 45mm	**£1.82**
MB5 Box 150 x 100 x 60mm	**£2.50**

ELECTROLYTIC RADIAL CAPACITORS

µF	16V	25V	63V	100V	450V
0.47	–	–	**£0.05**	**£0.07**	–
1.0	–	–	**£0.05**	**£0.06**	**£0.15**
2.2	–	–	**£0.05**	**£0.06**	**£0.18**
4.7	–	–	**£0.05**	**£0.08**	–
10	**£0.05**	**£0.05**	**£0.06**	**£0.08**	**£0.44**
22	**£0.05**	**£0.05**	**£0.09**	–	–
47	**£0.06**	**£0.06**	**£0.11**	–	–
100	**£0.06**	**£0.09**	**£0.11**	–	–
220	**£0.09**	**£0.12**	**£0.31**	–	–
470	**£0.15**	**£0.19**	**£0.57**	–	–
1000	**£0.22**	**£0.29**	–	–	–
2200	**£0.37**	**£0.57**	–	–	–
4700	–	**£1.11**	–	–	–

ELECTROLYTIC AXIAL CAPACITORS

µF	16V	25V	63V	100V	450V
0.47	–	–	–	**£0.15**	–
1.0	–	–	**£0.10**	**£0.10**	**£0.19**
2.2	–	–	**£0.10**	**£0.10**	**£0.22**
4.7	–	**£0.09**	**£0.10**	**£0.10**	**£0.34**
10	–	**£0.12**	**£0.12**	**£0.12**	**£0.48**
22	–	**£0.09**	**£0.13**	**£0.17**	**£1.06**
47	**£0.10**	**£0.11**	**£0.16**	**£0.20**	–
100	**£0.10**	**£0.13**	**£0.21**	–	–
220	**£0.13**	**£0.18**	**£0.42**	–	–
470	**£0.21**	**£0.24**	**£0.69**	–	–
1000	**£0.33**	**£0.40**	**£1.05**	–	–
2200	**£0.52**	**£0.64**	–	–	–
4700	**£0.90**	–	–	–	–

LINEAR ICs

CA311E	**£0.28**
CA324	**£0.35**
CA555	**£0.22**
CA741CE	**£0.28**
CA747CE	**£0.39**
CA3046	**£0.37**
CA3080	**£0.72**
CA3130	**£0.98**
CA3130E	**£0.98**
CA3140	**£0.56**
CA3240	**£1.22**
ICL7621	**£1.70**
ICM7555	**£0.43**
ICM7556	**£0.96**
LM301A	**£0.25**
LM348N	**£0.31**
LF351N	**£0.36**
LF353	**£0.41**
LM358N	**£0.27**
LM377	**£2.57**
LM380N	**£1.12**
LM381	**£2.70**
LM386	**£0.48**
LM387	**£1.60**
LM392N	**£0.79**
LM393N	**£0.28**
LM748CN	**£0.31**
LM1458	**£0.26**
LM3900	**£0.72**
LM3914	**£2.70**
LM3915	**£2.70**
MC3340	**£1.60**
MC4558	**£0.36**
NE531	**£1.56**
NE556N	**£0.36**
NE567N	**£0.47**
NE5532	**£0.80**
NE5534	**£0.60**
TBA120S	**£0.90**
TBA810S	**£0.68**
TBA820M	**£0.39**
TDA2002	**£1.04**
TDA2030	**£1.18**
TL061	**£0.35**
TL062	**£0.42**
TL064	**£0.46**
TL071CP	**£0.32**
TL072CP	**£0.68**
TL074CN	**£0.48**
TL081	**£0.33**
TL082CP	**£0.54**
TL084	**£0.63**
TL084CN	**£0.46**
UA733	**£0.64**
ULN2003	**£0.52**
ULN2004	**£0.48**
ZN414Z	**£1.16**
ZN425E	**£4.68**
ZN426E	**£2.61**
ZN427E	**£8.82**
ZN428E	**£6.12**
ZN435E	**£6.19**
ZN448E	**£7.92**

THYRISTORS

PO102AA	**£0.30**
TIC106D	**£0.40**
TIC116D	**£0.66**
TIC126D	**£0.77**

EPROMS & RAMS

2716	**£4.46**
2732	**£4.84**
27128-20	**£3.69**
2764-25	**£3.00**
27C64-25	**£2.17**
21728-20	**£3.15**
27C128-20	**£3.31**
27256-20	**£4.99**
27C256-20	**£4.21**
27C512	**£3.56**
27C010	**£6.98**
6116-10	**£1.53**
6264-10	**£3.06**
62256-10	**£5.35**
4164-15	**£1.78**
41256-10	**£2.80**
511000-8	**£5.61**
514256-8	**£5.61**

SOLDERING IRONS

Antex Soldering Irons	
M 12 Watt	**£8.18**
C 15Watt	**£8.18**
G 18Watt	**£8.41**
CS 17Watt	**£8.31**
XS 25Watt	**£8.41**
ST4 Stand	**£2.97**
35Watt Gas Iron	**£11.58**
'Gascat' Gas Iron	**£15.26**
Low Cost 15 Watt Iron	**£3.93**
Desolder Pump	**£3.00**
Antistatic Pump	**£4.25**
22SWG 0.5Kg Solder	**£7.40**
18SWG 0.5Kg Solder	**£6.60**
1mm 3 yds Solder	**£0.62**
Desolder Braid	**£0.87**

RF CONNECTORS

BNC Solder Plug 50R	**£0.93**
BNC Solder Plug 75R	**£0.96**
BNC Crimp Plug 50R	**£0.68**
BNC Crimp Plug 75R	**£0.68**
BNC Solder Skt	**£1.08**
BNC Chassis Skt	**£0.80**
PL259 5.2mm	**£0.68**
PL259 11mm	**£0.62**
RND UHF socket	**£0.68**
SQR UHF socket	**£0.45**
F Plug RG58	**£0.30**
F Plug RG6	**£0.27**
N Plug RG8	**£1.60**
N Socket RG8	**£1.40**
BNC Crimp Pliers	**£17.44**

PCB EQUIPMENT

Photo Resist Aerosol Spray	**£4.47**
Developing/Etching Tray	**£1.35**
Plastic Tweezers	**£0.55**
Transfer Spatular (Alfac)	**£0.70**
Clear Drafting Film (A4 size)	**£0.44**/sheet
Ferric Chloride (0.5Kg)	**£2.45**
UV Exposure Unit 2x8W	**£76.31**
Etch Resist Pen (High Q)	**£0.78**
Transfer Eraser (Alfac)	**£0.55**
Opaque Drafting Film (A4)	**£0.46**/sheet
Tin Plating Powder 90g	**£12.93**
PCB Polishing Block	**£1.84**
Small Knife + spare blade	**£0.39**
Alfac Transfers – full range in stock	
How to Make PCBs (Book)	**£2.50** – No VAT

STRIPBOARD 0·1" PITCH

64mm x 25mm	**£0.27**
64mm x 95mm	**£0.90**
95mm x 127mm	**£1.50**
95mm x 431mm	**£4.80**
119mm x 454mm	**£6.20**

BREADBOARD

81mm x 60mm	**£3.30**
175mm x 42mm	**£3.74**
175mm x 67mm	**£5.56**
203mm x 75mm*	**£7.36**

* Supplied on mounting plate with terminal posts

1.6mm Thick	**PHOTO RESIST GLASS FIBRE**		**PHOTO RESIST PAPER COMP.**	
Size	Single Sided	Double Sided	Single Sided	Double Sided
4x6"	**£1.58**	**£1.79**	**£1.20**	**£1.47**
6x12"	**£4.62**	**£5.15**	**£3.46**	**£4.20**
9x12"	**£6.93**	**£7.77**	**£5.19**	**£6.36**
10x12"	**£8.87**	**£9.81**	**£6.78**	**£8.30**
12x12"	**£9.09**	**£10.19**	**£6.83**	**£8.34**
			COPPER CLAD UN-COATED	
160x100mm	**£1.94**	**£2.20**	**£0.70**	**£0.74**
203x114mm	**£2.52**	**£2.78**	–	–
220x100mm	**£2.58**	**£2.88**	**£1.00**	**£1.05**
233x220mm	**£5.67**	**£6.41**	**£2.38**	**£2.52**
233x160mm	**£3.99**	**£4.41**	**£1.75**	**£1.89**

CAPACITORS

Ceramic Mini Disc 100 & 63V
1.0pF to 100nF
1pF-1nF **£0.06**, 1n2-2n7 **£0.07**,
3n3-4n7 **£ 0.12**,
10n & 12n **£0.07**
Polystyrene 160V 5% 47pF to 10nF
47p-2n2 **£0.09**, 2n7-10n **£0.12**

D CONNECTORS

	Plug	Socket
9 Pin	**£0.29**	**£0.30**
15 Pin	**£0.39**	**£0.39**
15 Pin H.D.	**£0.49**	**£0.90**
23 Pin	**£0.40**	**£0.49**
25 Pin	**£0.48**	**£0.50**
9 Way plastic cover		**£0.30**
15 Way plastic cover		**£0.33**
23 Way plastic cover		**£0.36**
25 Way plastic cover		**£0.36**

SWITCHES

3amp 250v 6.4mm ϕ mounting	
SPST Toggle	**£0.58**
SPDT Toggle	**£0.60**
SPDT CO Tog	**£0.64**
DPDT Toggle	**£0.68**
DPDT CO Toggle	**£0.76**
DPDT CO Toggle (biased)	**£1.20**
DPDT CO Toggle (biased 1 way)	**£1.20**
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WITH PRACTICAL
ELECTRONICS
INCORPORATING ELECTRONICS MONTHLY

VOL. 23 No. 7 JULY '94

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PREDICTABLE

One thing about this job is that it is rarely dull or predictable. Your letters often prove to be very interesting and challenging. It is also sometimes very rewarding. To take a couple of recent examples: yesterday I received a letter from a reader gently complaining that he had to go to three different suppliers for parts for one of our projects. He made the comment that his wife had similar problems with a knitting magazine she *used* to read.

It is, of course, a problem we are well aware of and one that is brought out in *Shoptalk* each month. With so many components now available it is impossible for one supplier to stock everything. Even the very largest suppliers have certain limitations in their range.

If we are to publish innovative projects then I do not feel we should be restricted because some components come from unusual sources. There are, of course, a number of projects where all the bits can easily be purchased from just one supplier. The more specialised designs often need a little more searching around although we do try to give suppliers' names in *Shoptalk* for those "difficult" components.

I suppose our view is that we would prefer to publish projects with easy to find components but if a project requires something special we will still publish it, provided we can tell readers where to get the item. It's then up to you to decide whether to build it or not. I know that buying from various sources pushes up the price with extra postage and packing charges but very often the overall cost still makes the project worthwhile.

REWARDING

At first the letter in my second example also gave me the impression that the reader was not happy: it started "Farewell to *Everyday Electronics*".

Oh dear, I thought, what have we done to upset this reader? But it went on "I have been a reader and constructor since issue No 1 . . . I have every copy to this date. Circumstances of diabetes and cataracts have forced me to quit."

The reader went on to thank us for a wonderful hobby and to offer his set of magazines to anyone we felt could use them.

I would like to say thank you to all our regular readers and for all your letters, complimentary or not, they keep us on our toes, make us think about what we are publishing and, of course, can be very rewarding. It's your magazine – please keep the comments, brickbats (and praise) coming.

And finally, a special thanks to the above reader and to everyone who has supported us over the years – long may you continue to read *Everyday with Practical Electronics*.

Mike Kenward

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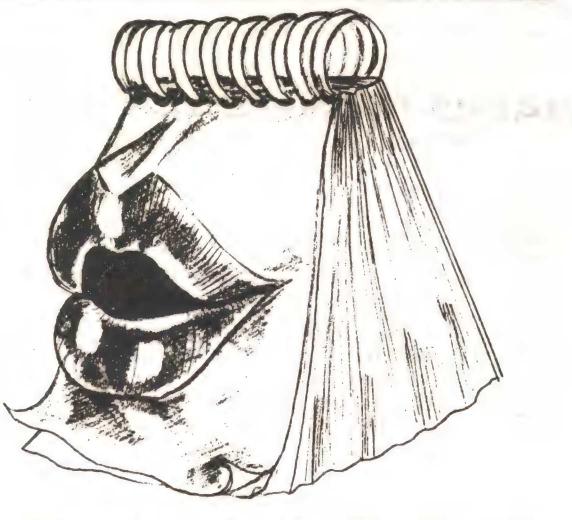
VOXBOX

SOLID STATE VOICE RECODING BOARD



GUY DANCE and JEREMY AUSTIN

Using just 128 thousand, yes thousand, capacitor cells in a single i.c. package you should be able to get your message across with this single board voice recorder.

Will store spoken messages up to 20 seconds long and play them back at the touch of a button.

GPT, one of the major European Telecomms Companies is the kind of gentle giant that likes to do all it can to encourage youngsters into a career in electronics. When GPT, who's name comes from GEC-Plessey Telecomms, was invited to participate in the local *Technology in Action Day,* the annual feature of a campaign to promote engineering in schools, two design engineers tore themselves away for a short break from designing the successor to the world-standard System X telephone exchange, and created the Voxbox.

Developed to be a straightforward and involving project, suitable for total novices by being easy to make and use, the Voxbox was a great success and appears here for the first time in any magazine.

WHAT IS IT

Voxbox is a non-volatile voice recording board, made from just a few components. It can record and replay a message up to twenty seconds long (or two messages, each up to ten seconds long), features simple push-button operation and is non-volatile when the battery is disconnected.

We thought the Voxbox could be used as an electronic message pad, perhaps for someone to leave a message for their parent indicating they may be late home from the disco! With the addition of a low-current l.e.d., the Voxbox could let you know there was a message waiting.

Its sensitive microphone allows it to be used with a telephone, for instance to record spoken addresses or travel directions, and we found it could capture and replay tone dial signalling sequences to permit one-button dialling using any telephone connected to a System X telephone exchange.

With the addition of a simple timer circuit it could be used as part of a versatile system for making repeated PA announcements. For helping the disabled, the Voxbox is small, cheap and versatile enough to be used as an audible beacon, perhaps continuously calling out warnings of some unexpected obstruction in a thoroughfare, for example, used by blind people.

Disabled users might also find the Voxbox useful when dealing with a doorphone. It also has an obvious application in reproducing sound effects say for a stage production.

HOW IT WORKS

The usual method of storing analogue signals such as voice in an electronic memory is to convert the signal into a sequence of digital numbers. This is done by sampling the signal about 8000 times per second (for 'phone quality speech) and digitising each sample.

If each sample is converted into a single byte, then the digital value of the byte (somewhere between 0 and 255) represents, say, the voltage of the signal at the time when it was sampled. Each byte value sampled from the signal can then be packed away in a conventional chunk of RAM, stored until required, and then read back in sequence.

This project works according to quite a different principle. Voxbox stores all its signal samples in analogue form and Fig. 1 is a block diagram of the ISD1020AP voice recorder chip which does the job.

Digitally-minded electronics enthusiasts might wonder how this storing of an analogue quantity is possible. Perhaps it helps to remember that a capacitor can carry any voltage, without the restriction of having to keep to whole number values such as 0 to 255.

There are 128 thousand tiny capacitor cells inside the ISD1020, which when recording charges a new cell every 160 microseconds or so, allowing messages up to 20 seconds long to be held. The amount of charge in each cell corresponds to the voltage at the moment of sampling the voice signal.

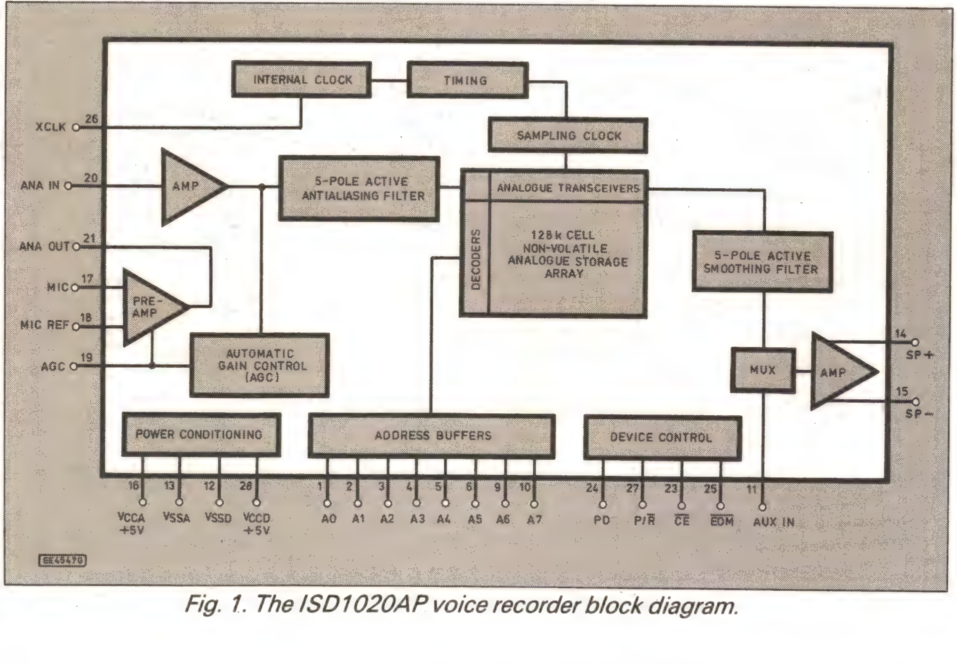


Fig. 1. The ISD1020AP voice recorder block diagram.

Replaying is done by presenting the value of each cell to the output amplifier at the same speed as in the recording. Inside the ISD1020AP, special care has been lavished on the construction of each capacitor cell to reduce stray leakage, and this results in storage times of anything up to thirty years or longer, even with no battery connected.

BASIC TECHNICAL DATA

The manufacturer's application circuit example for the ISD1020 voice record/playback chip is shown in Fig. 2. In this simple circuit the ISD1020 needs few supporting components, but can deal with only one message up to 20 seconds long.

The chip could be supplied by a six volt battery. Tables 1 and 2 summarise the features of the circuit.

The voice recorder i.c. is controlled by three switches, not by logic as in the Voxbox design. To get the chip to record, the Record/Play switch must first be set to record, then the Power Down switch must be set to '0' to get the chip out of standby mode, and finally the chip select must be brought low, which causes recording to start.

Recording will continue until the device fills its memory, or the record switch is turned to playback, or the power down switch is operated. When any of these occur, an end of message marker is written to the chip's non-volatile memory which will be used during playback to terminate messages less than 20 seconds long.

PLAYBACK

To start Playback, select playback mode, set power down to '0', and momentarily set the chip select switch low. Playback will terminate when the chip finds the end of message marker.

The application circuit Fig. 2 uses the ISD1020's integral power amplifier to drive the loudspeaker, see block diagram Fig. 1. To avoid excessive loading, a 10 ohm series resistor is required with speakers of less than 16 ohms.

Readers might be interested to note that another chip in the series, the ISD1016, will give better quality reproduction than the ISD1020 because it samples the incoming signal at a higher frequency. This sampling speed is set internally, but as the internal memory array is the same size, the higher quality reduces the maximum message length for the 1016 to 16 seconds.

Table 1: Application Example – Basic Device Control

Control Step	Function	Action
1	Power up chip and select record/playback mode	1. PD = LOW 2. $P/\overline{R}$ = As desired
2	Set message address for record/playback	Set addresses A0-A7
3	Begin playback/record	$\overline{CE}$ = Pulsed LOW
4	End cycle	$\overline{CE}$ = HIGH and $\overline{EOM}$ reached

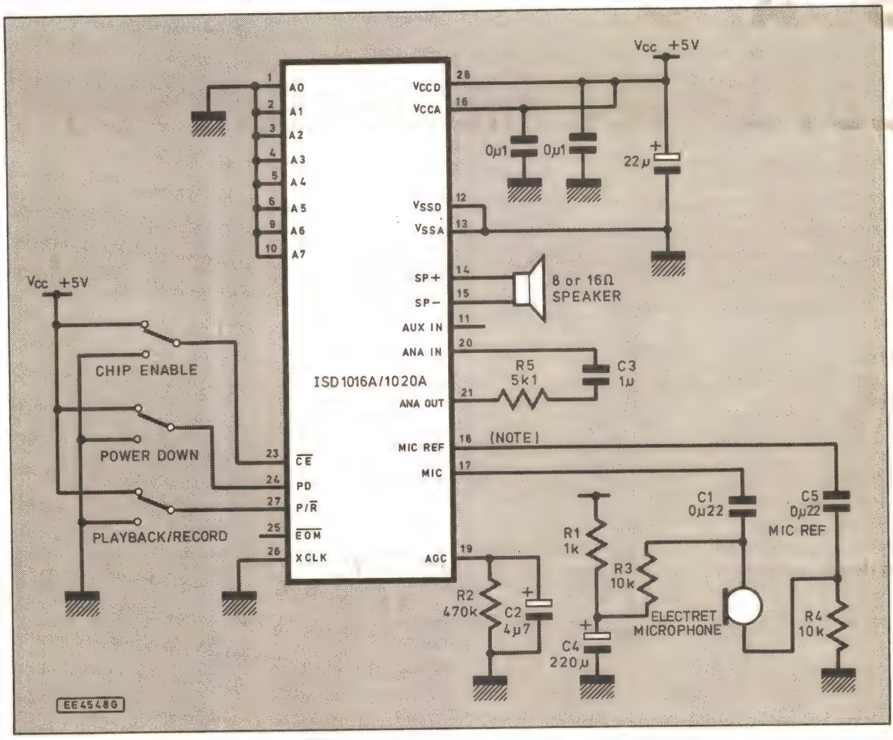
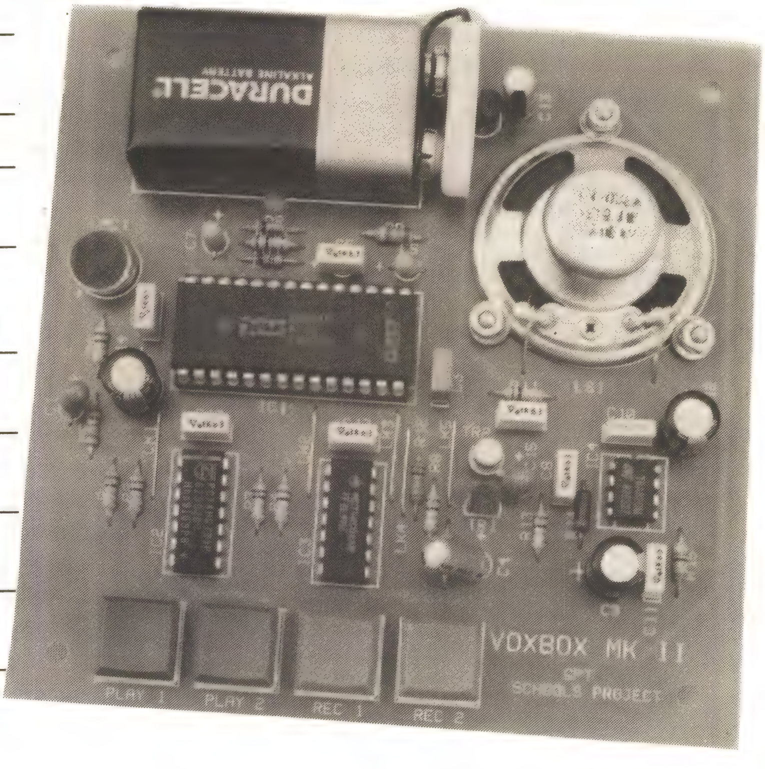


Fig. 2. Application circuit example for the ISD1020. Note: If desired, pin 18 may be left unconnected (microphone pre-amp noise will be higher). In this case, pin 18 must not be tied to any other signal or voltage.

Table 2: Application Example – Passive Components

Part	Function	Comments
R1	Microphone power supply decoupling	Reduces power supply noise
R2	Release time constant	Sets release time for AGC
R3	Microphone biasing resistor	Provides biasing for microphone operation
C1	Microphone DC-blocking capacitor. Low-frequency cutoff	Decouples microphone bias from chip. Provides single-pole low-freq. cutoff
C2	Attack/Release time constant	Sets attack/release time for AGC
C3	Low-frequency cutoff capacitor	Provides additional pole for low-frequency cutoff
C4	Microphone power supply decoupling	Reduces power supply noise
C5	Common-mode capacitor	Provides common-mode noise rejection



CIRCUIT DESCRIPTION

The full circuit diagram for the Voxbox is shown in Fig. 3. IC1, the ISD1020AP, is the heart of the project and all the rest of the circuitry is included just to drive it.

To save battery life, the voice recorder chip and the audio amplifier are turned off until required, and generally we will describe the sequence of events after any one of the switches S1 to S4 has been pushed. Fig. 4 indicates the function of the four switches.

Pins 1, 2, 4 and 5 of IC2, the four input AND gate, sense whenever any switch is pushed, and the output, pin 6, goes low. The cross-coupled NAND gates made from IC3c (pins 8, 9 and 10) and IC3d (pins 11, 12 and 13) form a set-reset latch, the "activity" latch which will be set by IC2a pin 6. Thus a brief push on any of the switches will trip the activity latch, causing IC3c pin 8 to go low and signalling to IC1, via its Power Down (PD) input on pin 24, that it is time to wake up. The same signal pulls down the base of transistor TR2, via resistor R12, and turns on the supply current to the power amplifier IC4.

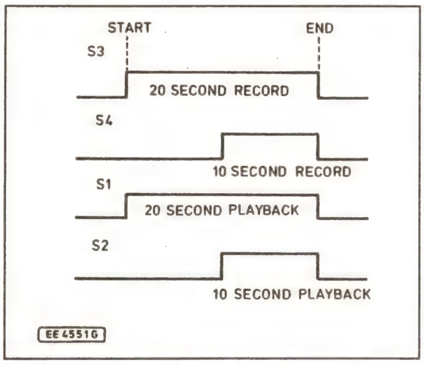


Fig. 4. Operating functions of the four press-switches S1 to S4.

The output of IC1 is rated for driving a loudspeaker directly, but a physically small loudspeaker is required if it is to be mounted on the circuit board with all the other components. Small loudspeakers are not renowned for their efficiency, so a TBA820 audio amplifier IC4, helps raise the output from IC1 to improve sound quality.

RECORD/ PLAYBACK

The above circuit action establishes a power supply to all parts of the circuit. Meantime, the signal which tripped the activity latch in the first place, also causes IC3b pins 4 and 5 to go low, so the output pin 6 goes high and starts charging capacitor C4 via resistor R7. After a short while, the voltage on C4 rises sufficiently to turn on transistor TR1, its collector (c) goes low, and supplies the Chip Enable signal to IC1 pin 23, causing the voice recorder chip to start functioning.

By this time, IC2b pin 8 will have gone low if either Record 1 or Record 2 switch was pushed, so IC1 pin 27, the input which selects between record or replay, will be low if record function is required, or high otherwise. This same signal also energises the microphone via resistors R5 and R6 when record is required.

The final gate in the circuit, IC3a (pins 1, 2 and 3) senses whether Record 2 or Play 2 switches have been pushed. In either case IC3a output pin 3 goes "high" and sets bits 4 and 6 of the address input on IC1 pins 1, 2, 3, 4, 5, 6, 9 and 10, i.e. starts the recording or replay halfway through the memory. Chip Enable is used to clock into IC1 the state of the address inputs and the playback/record pin, and it must not go low until at least 31·25mS after the Power Down signal.

All will now continue with no change until the activity latch is reset, via diode D1, by IC1 pin 25 going low; the "End of Message" output. This signal is supplied by IC1 when you release a RECORD switch in record mode, or when you come to the end of a recording in playback mode.

The power-up reset network, R10, D2, and C7, also operates to reset the activity latch when the circuit is first connected to its battery. While capacitor C7 is still at a low voltage, before it has charged via resistor R10, it ensures the activity latch cannot become set, and prevents IC1 from functioning before intended.

The output from the voice recorder chip IC1 is a.c. coupled into the output power amplifier IC4 via capacitor C8 and limited by resistor R11, the volume control. The resistor is chosen to give a reasonable level of undistorted speech, reducing it will increase the volume, and vice versa.

POWER SUPPLY

A PP3 battery was chosen for ready availability and to allow easy mounting on the board with the other components. The circuit will work from a five volt supply, and an LP2950 voltage regulator, IC5, specially chosen because it consumes very little power, reduces the battery supply. This regulator operates all the time the battery is connected, as do all the gates, but their combined current consumption is very small.

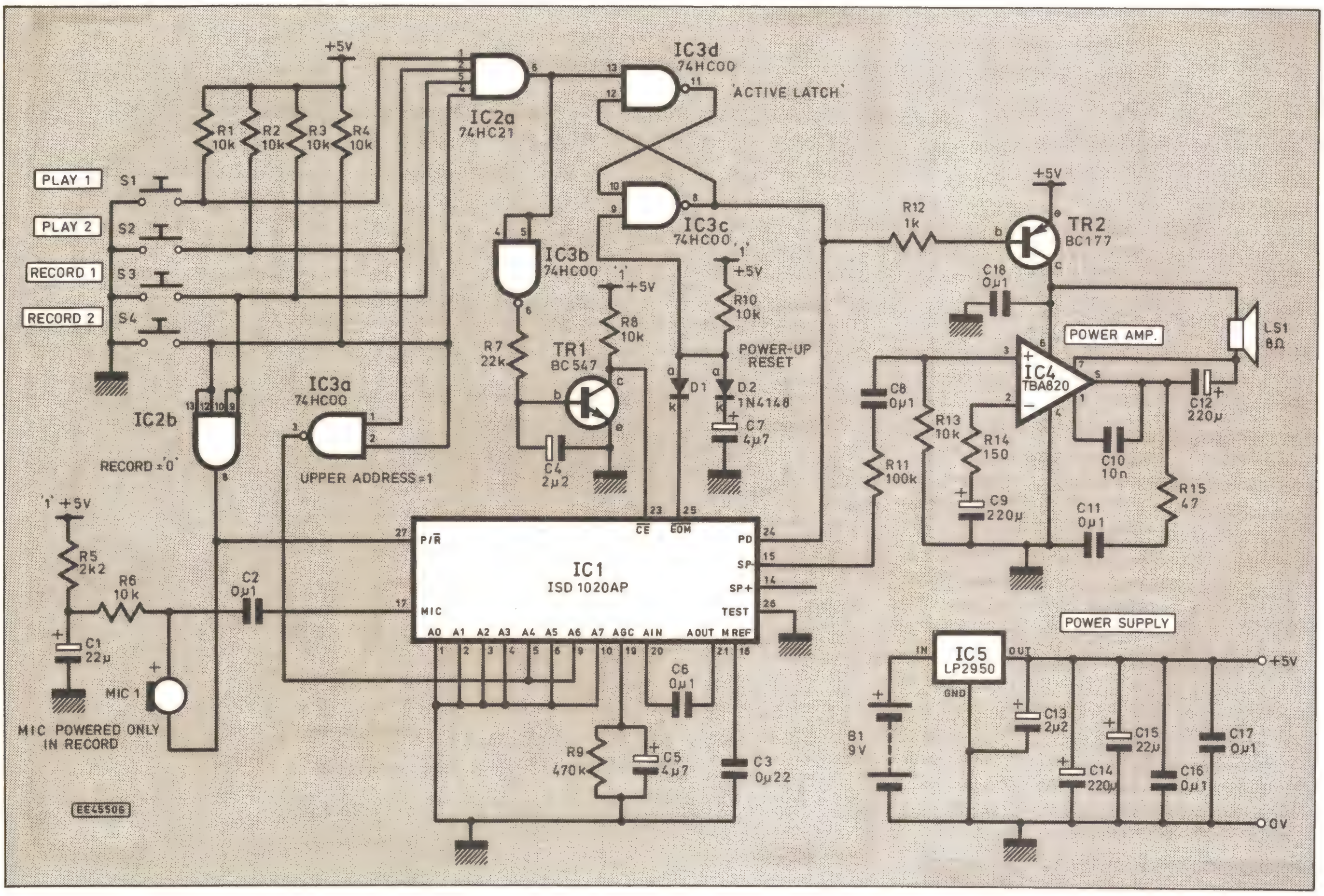


Fig. 3. Complete circuit diagram for the Voxbox Solid State Voice Recording Board.

CONSTRUCTION

All the components for the Voxbox are accomodated on a single printed circuit board (p.c.b.) and the topside layout and full size underside copper foil master pattern is shown in Fig. 5. This board is available from the *EPE PCB Service*, code 885.

You will generally find construction easier if you deal with short components first, leaving the taller ones till last. Start by inserting and soldering all the wire links and then the sockets for the i.c.s, remembering to bend a couple of the legs of each

COMPONENTS

Resistors

R1 to R4, R6, R8, R10, R13	10k (8 off)
R5	2k2
R7	22k
R9	470k
R11	100k
R12	1k
R14	150
R15	47

All 0·6W 5% carbon film

See SHOP TALK Page

Capacitors

C1, C15	22µ radial elect. 25V (2 off)
C2, C6, C8, C11, C16 to C18	0µ1 polyester (7 off)
C3	0µ22 polyester
C4, C13	2µ2 radial elect. 6·3V (2 off)
C5, C7	4µ7 radial elect. 6·3V (2 off)
C9, C12, C14	220µ radial elect. 25V (3 off)
C10	0µ01 polyester

Semiconductors

D1, D2	1N4148 signal diode
TR1	BC547 *npn* silicon transistor
TR2	BC177 *pnp* silicon transistor
IC1	ISD1020AP direct analogue storage, voice recorder
IC2	74HC21 or 74HCT21 CMOS dual 4-input AND gate
IC3	74HC00 CMOS quad 2-input NAND gate
IC4	TBA820M low voltage power amplifier
IC5	AD2950 +5V low power voltage regulator

Miscellaneous

S1 to S4	Press-to-make, p.c.b. mounting, keyboard switches, with red and blue caps (2 off each)
LS1	Miniature 8 ohm loudspeaker, 38mm (1·5in.) dia.
MIC1	Min. electret microphone
B1	9V PP3 battery, with clip

Printed circuit board available from the *EPE PCB Service,* code 885; 8-pin d.i.l. socket; 14-pin d.i.l. socket (2 off); 28-pin d.i.l. socket; double-sided sticky pads; single-core link wire; 2·5mm bolts, washer and nuts (3 off each); solder etc.

Approx cost guidance only **£32**

VOXBOX – VOICE RECORDING BOARD

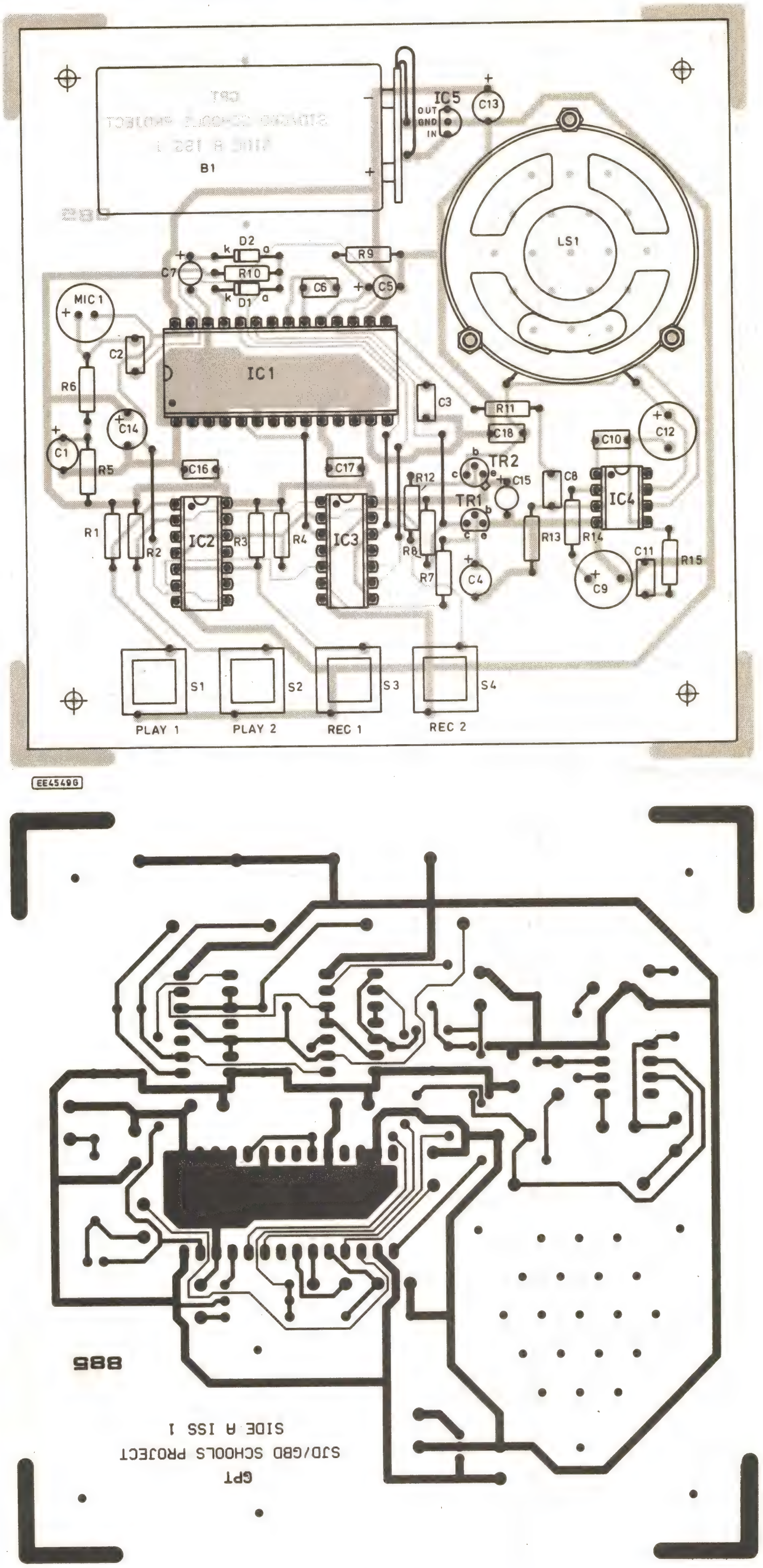
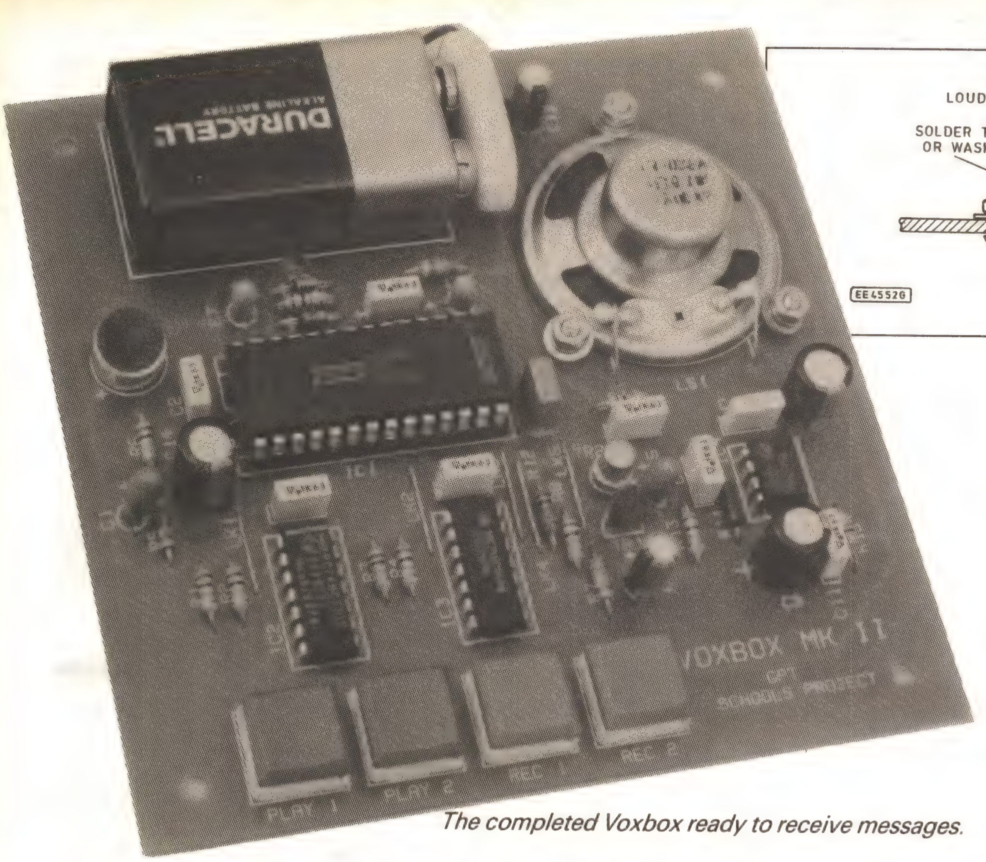


Fig. 5. Printed circuit board component layout and full size copper foil master pattern. The p.c.b. layout was produced by Richard Kellaway of Talos Designs, Poole, Dorset.



The completed Voxbox ready to receive messages.

component slightly so it won't fall out before you are ready to solder it. Next, the resistors and diodes, then transistors, regulator, microphone and capacitors can be soldered in position. Do make sure the diodes, electrolytic capacitors, microphone, i.c. sockets, regulator and transistors are the right way round.

Using the 2·5 mm nuts, washers and bolts, mount the loudspeaker LS1 on the p.c.b. as shown in Fig.6, and connect it to the circuit with two short flying leads. Solder in the switches, using red caps for S3 and S4, the Record switches, and blue caps for the Play switches S1 and S2. Finally solder in the battery connector, being very careful to get it the right way round.

Examine the assembled board carefully and remove any short circuits caused by "solder-bridges". When you think all is well, carefully insert all the i.c.s into their sockets. The best way to dodge electrostatic hazards, particularly to IC1, is to avoid handling the pins of the i.c.s at all, until they are inserted into their sockets. It is also a good precaution during this operation to discharge any stray static you may be carrying, and of course, you must be sure the i.c. is inserted into its socket the right way round.

The final operation is to connect the battery, taking care to get it round the right way, and hold it on the board with a piece of double-sided sticky tape.

POWER UP

With a bit of luck you should now have a perfectly functioning Voxbox. To Record, hold down a red button while you speak. To replay (Playback) , start the message going with a brief push on the appropriate blue button. If you hold down a Playback button, the message will loop.

If all this merely results in the dreaded electronic silence, disconnect the battery and examine the circuit carefully for "dry joints" or similar slip-ups. Is the speaker connected OK? Assuming this doesn't do the trick, you will have to get out the knife and fork to find out why.

Using an oscilloscope or a voltmeter if available, check that the output of the voltage regulator IC5 is five volts. Verify that the supply to the audio amplifier IC4 is turned on when you press any of the switches. Make sure IC2 pin 6 goes "low" while you hold down a switch. Check also to see if IC3 pin 8 goes up and down in synchronism with the messages, and with it IC1 pin 24. IC1 pin 23 should also go low.

If all is well with the activity latch IC3 and voice recorder chip IC1, perhaps there is a problem in the amplifier?

Is the amplifier supply, IC4 pin 8, going high to power up the chip? If it is, you could test the amplifier by briefly injecting a small signal into it. If you lack a suitable signal generator, observe sensible safety precautions while you put your finger momentarily on IC4 pin 3. This should produce a click or hum from the loudspeaker if the amplifier is working.

Make sure the recording process is working by watching the input on pin 27 of IC1 go low whenever a Record button is pressed, and check that the microphone is powered up during these conditions. Is the electrolytic capacitor C1 the right way round?

Finally, make sure the power is removed at the end of playback or record by watching the activity latch go high on IC3 pin 8. This will ensure maximum longevity of the battery.

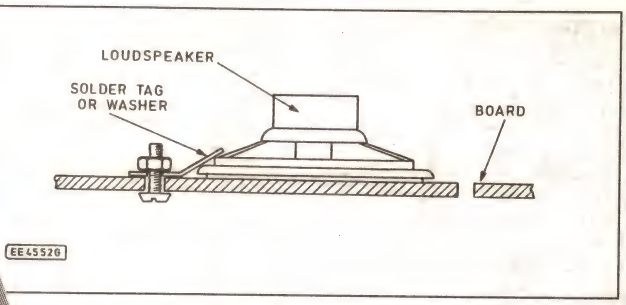


Fig. 6. Suggested method of mounting the loudspeaker on the printed circuit board. The battery is fixed to the p.c.b. using double-sided sticky tape.

IMPROVEMENTS

Purists may be interested in the following suggestions for improvements to the circuit.

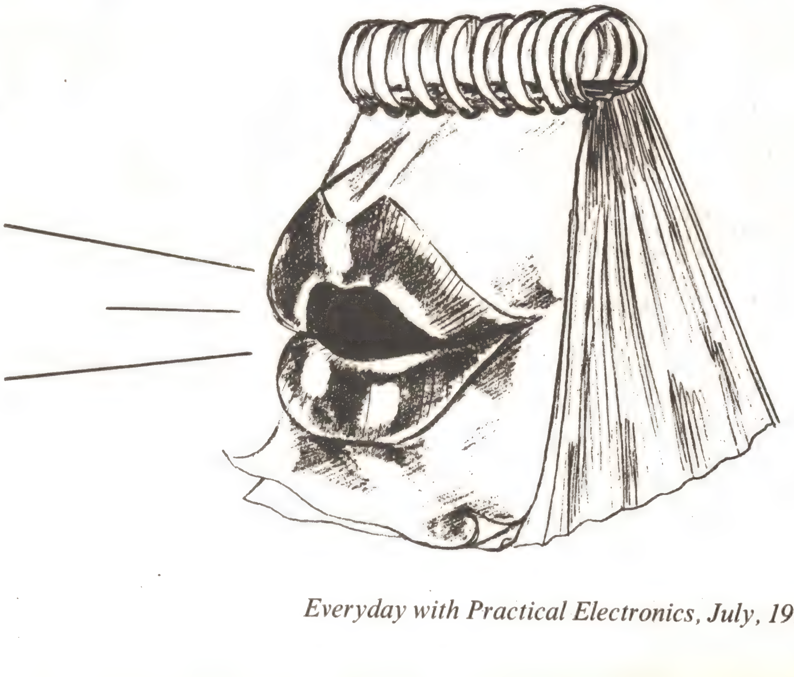
In our circuit the negative side of the microphone is connected to the output of a logic gate. This allows it to be turned on and off, but (theoretically) introduces some noise. There would be a slight improvement in signal quality if the microphone was connected directly to the ground of the p.c.b.

Experimenters may prefer to explore the capabilities of a crystal, ceramic, or dynamic microphone element, which could be connected directly to the MIC and MIC REF inputs of IC1.

There is a slight "pop" from the loudspeaker whenever the circuit turns on. This could be avoided by the addition of extra components to use pin 14 of IC1, the differential output.

Capacitor C6 connects the pre-amplifier to the output stage of IC1. We found this had to be a non-electrolytic type, to avoid possible instability.

Constructors may prefer to dispense with the voltage regulator IC5, which is quite expensive. In this case, a 6V battery will be required. If single button operation is not important, the addition of an extra switch to disconnect the battery supply might also be desirable. □



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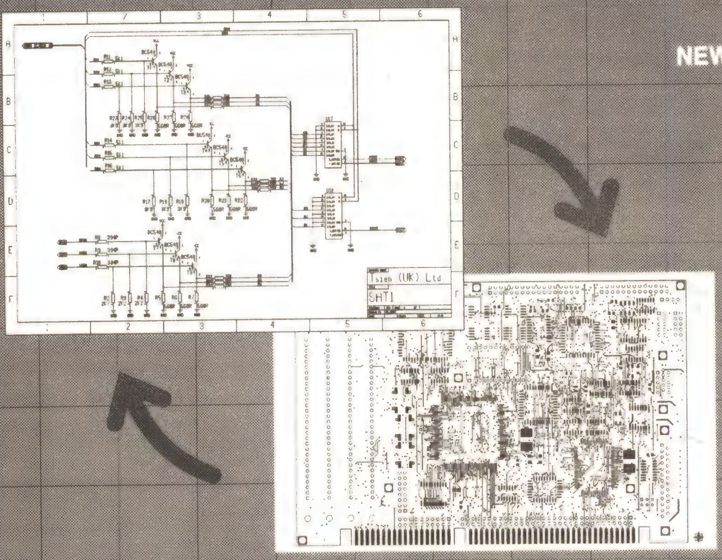

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FOX REPORT

by Barry Fox

Electronic Superhighway

When American President Bill Clinton and his Vice President Al Gore talk about creating an electronic superhighway for information (or National Information Infrastructure, to give it its more official stuffy title) they are predicting the inevitable.

But they are begging the most important question; how long the revolution will take to happen.

Humans are creatures of habit and will stick with the familiar way of doing things until some completely unexpected event forces a change.

For at least ten years now business executives have been able to hold video conferences. They can sit in offices around the world, talking to each other by television camera and screen. But it took the Gulf War, when many companies banned air travel, to open the business community's eyes to videoconferencing. The firms that provide the necessary equipment found orders doubling. Now the recession is making people look at the high price of air fares and the low cost of connecting videoconference equipment to the ISDN digital telephone lines which many offices now use.

Mechanical teleprinters and telex machines have for fifty years been sending typed messages down telephone lines. But telex machines need a trained operator and take minutes to send a full page. An electronic mail service lets anyone with a personal computer connect it by modem to a telephone line, and send a page in less than a minute. The big advantage of email is that the text arrives in a form which the receiving PC can store and edit, without the need for any retyping. But email systems are awkward to set up, for anyone other than a computer buff.

Neither email nor telex can cope with the thousands of pictorial characters in the Japanese alphabet. So Japanese business jumped at the chance of sending pages of written text by telephone, using a facsimile machine or fax. When the British postal services went on strike, in the 80s, the Japanese electronics companies already had low cost, easy-to-use fax machines ready to offer British business. Now fax is a way of life, with more and more private homes using £200 fax machines and PC users fitting fax cards.

The message arrives as a graphic image, not ASCII code which a PC can edit. So the PC has to use Optical Character Recognition software to try and convert the message into text. This cannot cope with handwritten text or corrections, and is unreliable even on pure font text unless it has been sent in "fine resolution" mode. Most people send faxes in standard mode.

As people fall over these problems they begin to see the value of connecting computers direct to a telephone line. But computers have so far developed faster than the telephone networks that can connect them. The "superhighway" will even things up.

Internet

The end of the Cold War was another of those unexpected events. The American military had set up its own electronic mail network to distribute secret information stored in giant computers at safe locations across the country. With the outbreak of peace the US government let universities use this system, dubbed the Internet, to share information. Then outsiders started to use "the net" to send messages, exchange news and arrange discussion groups in which people from all round the world post questions on electronic bulletin boards and get replies from other users, either immediately or days or weeks later.

Around 20 million people from all over the world now use the Internet. Most of the information is free, and there is so much of it that inexperienced users do not know where to start looking. Large documents, especially with pictures, take a long time to receive. It is quicker and easier, and cheaper on telephone bills, to go to a library and take books off the shelf and make a photocopy.

So this makes people see the need for better phone lines.

Although glass fibre is cheap, a laser is needed to inject the light into each end, and the conversion opto-electronics are expensive.

The stepping stone to the future is "fibre to the kerb". The telephone company lays optic fibre to junction boxes at the corner of the street. Opto-electronics in the box converts the light into electrical signals which are then fed into homes and small offices in the area by coaxial cable. If the distance from box to home or office is short, ordinary twisted pairs may do the trick.

Free Lunch?

And, finally, the superhighway comes into the home. But this leaves another begged question. Nothing is for nothing; in real life there is no such thing as a free lunch. Someone will have to provide all this information. So someone will have to pay for it.

The 32 volumes of the Encyclopaedia Britannica, contain 44 million words and 23,000 illustrations and should soon be available on the Internet, for people in university libraries to search by keyword, and eventually for the general public to use instead of buying the books. I can't wait to use it as a 24 hour reference source. But will I be able to afford it?

There are already information services available to anyone with a computer and electronic mail modem. I can search through all last year's newspapers, for every mention of any selected topic. But it will cost me several pounds per minute of time on the line. I can't justify that cost unless I am desperate for a fact. No student or casual user can possibly afford it.

Will governments pay to provide online information services, instead of public libraries? If so where will that leave people who do not have access to a computer?

Copying

And how to control valuable information, even when someone has paid to use it?

Anything in digital code, whether music, text, pictures or a computer program, can be copied. The copy is identical to the original. This is already alarming the record companies, who worry that people will make perfect copies of CDs onto digital tape instead of buying the original disc. It scares photographic libraries, too, who know that once they have sent a full quality picture down a line to a newspaper or TV station, they have lost control of it for ever.

The only information available free is information that no-one wants, which usually means that it is either advertising something or selling a political or religious point of view.

Britain is lucky to have one source of electronic information which is to all intents and purposes free. All the broadcast television stations now provide a teletext service, which lets anyone with a suitable TV set display pages of news, weather, travel and financial information. The cost of the BBC's service comes from the licence fee. Teletext on commercial TV is paid for by advertisements which tangle with the information pages.

When British computer company Digithurst recently started to sell its £500 board and software for a PC, which strips out the advertisements and displays only the information on the screens of office PCs, the teletext service providers warned of copyright infringement.

Innovations

A roundup of the latest Everyday News from the world of electronics

A New Outlook for Britain's Inventors?

BIRMINGHAM HOSTS FIRST INVENTORS' FAIR – *by Hazel Cavendish*

BRITISH inventors, probably the most under-rated and neglected body of innovators in Europe, at last appear to be getting some of the attention they deserve. As almost every brilliant idea that emerged was adopted, funded and developed by another country, the national conscience began to stir. Angry questions were asked from all quarters and newspaper leader writers took up their pens. Why were the British so timid in backing our own home-grown genius? Academics claimed that countless hours of research and development in our own Universities benefited everyone in the world except the inventor himself, and the country which educated his genius.

Suddenly it is all happening. Government is backing new developments in companies through the Innovation Unit of the Department of Trade and Industry, and gives some help and advice to individuals by pointing them in the right direction, and by providing some funding in certain cases. They were joined in a study in 1992 by the Technology Group of the CBI which admitted "The UK picture is somewhat bleak. In the world competitiveness scoreboard, put together by IMD Lausanne and the World Economic Forum, the UK ranks number 13 out of 22 OECD countries. The UK has not performed well in key areas such as a share of world trade, expenditure on R & D, and patenting."

This month has seen the first Fair ever held for British inventors, sponsored by Exchange and Mart, the DTI, the Institute of Patentees and Inventors, and given valuable assistance by the Design Council before it became a recent victim of Government cuts. The *Great British Innovation and Inventors' Fair,* held at the Pavilion Hall in the National Exhibition Centre in Birmingham from May 19-22 is to be a regular event and will become international next year.

The organisers, a small firm headed by Bournemouth business man Malcolm Cook, have been surprised and delighted by the response. A thousand stalls were booked in advance, 250 by British inventors, and the rest by research and development associations, major business organisations, patent agents, finance firms on the look-out for new joint ventures, private investors and interested manufacturers.

An extraordinarily diverse mix of inventions came in from all over Britain, ranging from innovative aids to industry – many of them based on electronics – to a large number likely to interest motor manufacturers and industry generally, with others destined to improve our quality of life. Many outstanding inventions were exhibited which had already been awarded and funded by the DTI Smart scheme.

Wide Range of Inventions

Originating from Keele University was a robotic aid which increases the independence of the severely disabled, able to be fully operated through the blink of an eye. Appropriately from Cornwall, Jonathan Marsh of Environmental Tracing Systems offered a Detector for environmental monitoring which can be used on a boat and uses laser and white light technology to effect instantaneous monitoring.

Phil Williams from Swanage in Dorset, a communications electronics consultant exhibited his Touchpad Sensor, an invention which turns any surface into a microswitch or sensor. He describes this as 'ideal for event detection, security system or vending machine.'

James Macleod from Renfrewshire, whose Audio Anchor won an award at last year's Salon International Des Inventions at Geneva, claims his motor vehicle security device is designed to prevent the 'smash and grab' thefts of audio systems which are posing a global problem costing millions of pounds every year throughout the world. Also reflecting public concern at the increase in violent attacks on the person was the 'Angel Alarm' invented by Charalambous Portelli of Security Technology in London. Described as an alternative to telephone emergency alarm calls, this personal hand-held system uses the G.P.S. system and provides a relay of accurate positional information.

Tim Snape of Abbotsbury, Dorset, exhibited his "Dive Cat", a communication and tracking system for use by scuba divers. Professor Edward Williams showed an interesting exhibit in his Magneto-Optic Security Stripe which can be read remotely by a laser and was just one of the exhibits from Keele.

Although the fair was only intended for British inventors this year, a single interesting electronic entry was admitted from Bucharest. The product, which offers a network for parallel software processing and uses a micro multi-processor i.c., seeks British investment.

The Midi Melodeon which acts as a trigger for midi sound sources. It has no reeds and may be configured for different keyboards.

Broker

Prominent among the business exhibitors was the London-based firm 'Inventalink', which can be described as an inventor's broker and management agent. This Company established its business 14 years ago to fill what they saw as a gap in the provision of services to inventors. They now operate from Clipstone Street in London.

"Inventors tend to go to a patent agent and, if they are not sophisticated people, they think they are going to become millionaires if they get a patent," said Richard Paine, their Marketing Director. "The most difficult thing is to launch a product and produce it to industry. Most inventors talk about manufacturers, when they should be talking about marketing companies. Our company is very market-orientated. We are a team of 12, and look at 2,000 to 3,000 inventions every year, assess their commercial viability, and take on a hundred or so. Our expertise is being able to open doors to industry."

"Pity the Poor Inventor"

Trevor Baylis – an inventor who has been featured by the BBC on *Tomorrow's World* and is known for many innovative products which he has introduced over the years, is one individual beating the big drum for recognition of the private inventor, and awareness of the difficulties and expenses he faces in getting his product accepted.

"You might say we are an endangered species, labouring under the prohibitive cost of patents which are at present the only effective means of protecting ourselves against predators. The inventor is easily robbed by opportunists and denied any credit for his invention. A system is needed to protect, assist and encourage those individuals whose ideas add to the universal pool of knowledge."

Baylis believes private inventors should be given the same protection as artists, writers and architects – namely, copyright. "We must find a suitable safe haven where people can go for help and assistance. This could well be the Institute of Patentees and Inventors, which deserves patronage at a high level. It is important that everyone connected with a new invention should receive a share in the profits. Inventors should also be reecognised in the Queen's Birthday Honours."

Change of Attitude

For the past three years the DTI has been running their Innovation Unit, set up the Government Minister Peter Lilley, to promote the exploitation of new ideas. Leading personalities in industry are enlisted to serve in the unit, changing every year. Diana Roberts, a spokeswoman for the department, admits the unit is not tuned to the individual inventor, but instead strives to achieve a change of attitude in the UK across a wide audience, and is mainly directed towards companies.

"It is very noticeable, for example, that the innovative companies are succeeding, despite the recession", said the Unit's "Best Practice" report. "They are evolving to meet the new challenges, and turning to their advantage the negative blockers which are inhibiting the others."

Diana Roberts says: "We are trying to change attitudes in Government and in Education. Why is it that the curriculum and teaching seem to turn people off careers in industry, off science and technology, and engineering?

On the finance side, why is it that the Companies complain the City thinks sort-term, while the City thinks the Companies can't manage long-term? Why is it that we have a marvellous science base – witness your inventors – but people who have the inventions don't commercialise them?"

Daft Idea?

Some of the most encouraging words uttered to the '90s innovators originate from the Cranfield School of Management in Bedfordshire. Andrew Berry, writing in a recent issue of *Intercity*, quotes Professor Simon Majaro, a former lawyer and Unilever executive who runs Cranfield's Centre for Creativity, as saying that creativity requires a 'tolerance of ambiguity' – an open mind, in other worlds – which is often missing in British management at all levels. Majaro's approach to creative thinking is what he calls 'the Intermediate Impossible.'

"Some of the greatest ideas we started from were, on the face of it, a daft idea." He cites the Sony Walkman as a classic example. Akio Morita, Chairman of Sony, originally said 'I want a mobile tape recorder that I can put in my pocket and take with me on walks.' It seemed impossible because of the size of good quality loudspeakers, but when they replaced speakers with headphones, it became possible. There was no new technology involved.

"Many new ideas seem impossible, but aren't – when you take a closer look."

New Technology Update

Ian Poole investigates the latest research developments in optical data links, nano-crystals and new i.c. packages..

COMPUTER networks and general data links are widespread in their use these days. In fact the volume of data being transferred electronically is increasing each year. Much of the data is passed along wires in the conventional way. This can take a variety of forms.

For low data rates like those used for most computer printers very few precautions need to be taken for short lengths. However, as the speed and distances increase data transmission becomes a little more difficult.

In many high speed links between different computers, coaxial cables are used. Whilst this method is capable of producing excellent results it can be prone to occasional data errors caused by electrical noise picked up along the line. In addition to this the data rate and bandwidth are often limited.

Laser L.E.D. Link

One way of overcoming these problems is to use an optical link. These links operate by running a light beam along an optical fibre. A light source at one end of the fibre is switched or modulated, and then converted back into electrical pulses at the other end by a detector.

Optical links can have very high bandwidths if high speed generators and sensors are used. In addition to this there is no possibility of interference from electrical noise as the data is transmitted in the form of light along a fibre.

Unfortunately high speed optical links are more expensive than their equivalent totally electronic ones. However, the development of a new high speed laser l.e.d. could herald a change to this.

The new l.e.d. has been developed by Hewlett Packard and it is a 650nm device built on a GaAs substrate which uses an active layer of GaInP between layers of tellurium and magnesium. The junction itself has an active area of 125µm and it consists of a *p+* area of AlGaAs and an *n-* area of GaAs.

The new structure is particularly attractive because of its relatively low cost. In addition to this its high efficiency and power enable cheap silicon detectors to be used in the receivers thereby further reducing the costs.

The diodes themselves are capable of switching at rates in excess of 100MHz. Once incorporated into a system data rates of around 100Mbits per second have been achieved over distances of 100 metres when used in conjunction with the correct optical cable. Currently this means that the cost of an optical system using these components would be comparable with an all electronic one of a similar specification.

Nano-Crystals

With the ever present need for faster and more complicated i.c.s, work is continually being undertaken to refine and improve existing processes used in semiconductor manufacture. These changes yield a steady improvement in the performance of devices over a period of time.

One indication of this can be seen in the processing power available on a single chip now compared to a few years ago. However to be able to produce a major leap forwards it is often necessary to look at completely new ideas.

News of one such idea which could shape the face of electronics well into the twenty first century is just beginning to filter out. It could lead to much faster i.c.s and even smaller sizes or increases in chip complexity.

The new idea has been developed at the University of Georgia in Athens and it involves the discovery of a new type of molecule called a nano-crystal. These crystals consist of a framework of less than a hundred atoms and they enable crystals to be grown to almost any shape.

The new discovery was found when researchers were investigating a set of materials called metallocarbohydrenes. To make these substances various materials were exposed to very intense levels of laser radiation in a vacuum which caused the material to vaporise. The resultant vapour was then combined with another element, often carbon, to produce the new material. In making these new materials the new nano-crystal structure was discovered.

The process to produce the nano-crystal itself involves bombarding titanium with laser radiation and then adding methane. This gives a nano-crystal containing titanium and carbon atoms.

In view of the constituents of the crystal it is expected that it should exhibit semiconductor properties. However in view of the minute size of the crystals, it is possible that other effects may predominate and the substance may become like ordinary conductors. There is even the possibility they may be insulators.

From this it can be seen that work is still at a very early stage of development. Much more still has to be done before it can be determined whether they can be used in the electronics industry. If they can then they may be one of the most important developments for several years.

New I.C. Packages

It is now several years since surface mount technology first started to take a grip on the electronics industry. Conventional leaded components still find many uses for testing circuits or for building small quantity production batches, and, of course, amateur electronics enthusiasts will continue to use them.

However, most large quantity production items use surface mount components throughout. Just look into a new video recorder, television, computer or any similar piece of consumer equipment to see how much surface mount technology is now used.

The main advantage of surface mount is that it is much easier to place these components using automatic methods, thereby greatly reducing production costs. Another advantage arises from the fact that pins do not have to be inserted through holes in the board, and this enables packages to be made much smaller. This is a distinct advantage in view of the increasing complexity of today's equipment.

Whilst designers have made great use of the reduction in size of components, the increasing pressure to pack even more into smaller and smaller spaces has meant that components are being made even smaller. New series of resistors and capacitors are being introduced and they are less than half the size of those in use only a few years ago.

In line with these size reductions new i.c. packages are being introduced for many standard logic i.c.s. The standard package used for the familiar 74HC and other similar families of logic is called the SOIC (small outline i.c.). It has a standard pin spacing of 1·27mm (0·050in.), and a typical 14-pin package measures 4·0mm by 10mm.

QVSOP

Now a company called Quality Semiconductor Inc., based in Santa Clara, California has introduced what it calls its QVSOP (Quality Very Small Outline Package?) package. This offers an outline of the same size as a standard 14-pin package, but with a pin spacing of only 0·4mm (the same as that used on many very high pin-out quad flat pack i.c.s).

The reduced pin spacing means that 48 leads can now be accommodated on this size of package. This is a great advantage because normally i.c.s with 48-pins would take up a large amount of board space, making p.c.b. layouts very difficult and cramped.

These packages are likely to be very useful in applications where computer busses are found. It will mean that a complete bus wide i.c. can be accommodated in a much smaller package.

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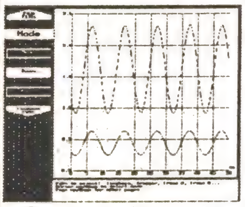

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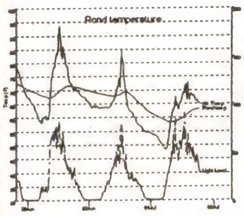

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11 Channel 10-bit

- Digital output
- Up to 18kHz sampling
- 0-2·5V input range

The ADC 11 provides 11 channels of analogue input in a case slightly larger than a matchbox. It is ideal for portable data logging using a "notebook" computer.

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ADC 12

1 Channel 12-bit

- High resolution
- Up to 17kHz sampling
- 0-5V input range

The ADC 12 is similar to the ADC 10 but offers an improved 12-bit (1 part in 4096) resolution compared to the ADC 10's 8-bit (1 part in 256).

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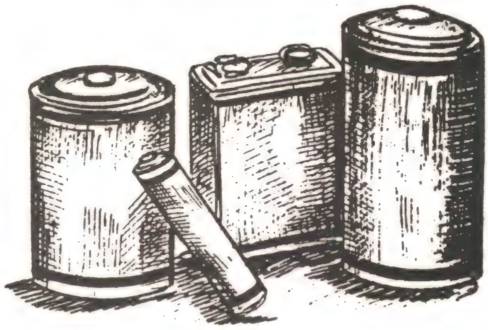


STEVE KNIGHT

Maintain the working efficiency of your cells with this easy-build charger. Modification details included for PP3's.

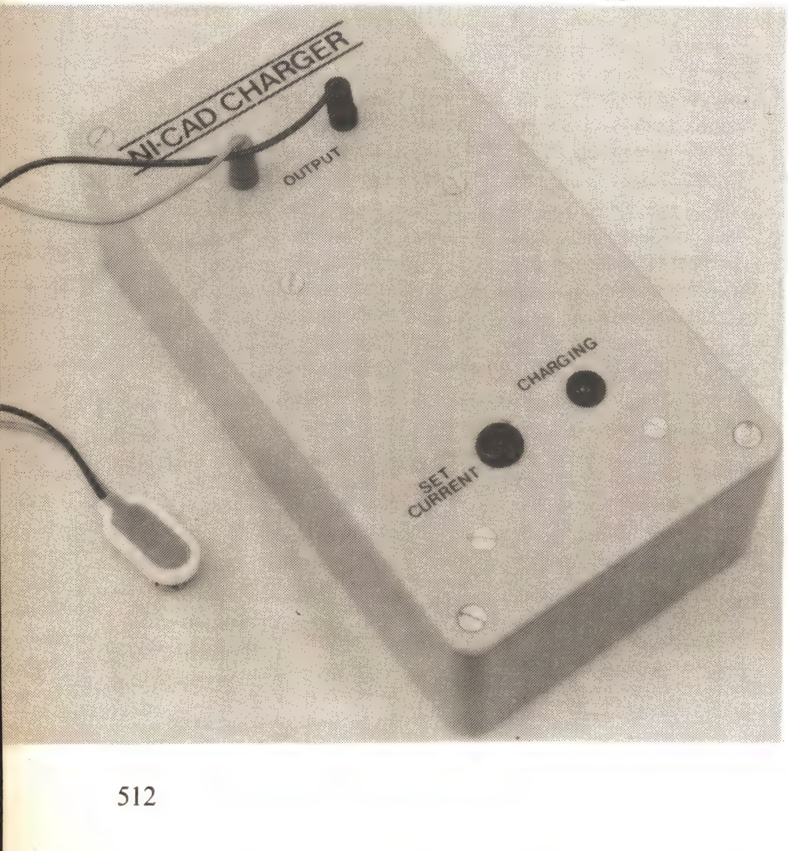
With the cost of alkaline and zinc-carbon primary cells and batteries seeming to creep up all the time, it makes sense, particularly if you do a lot of experimentation with battery powered projects, to switch over to nickel-cadmium (NiCad) rechargeable types. The initial outlay per cell is not all that much greater than the alkaline equivalents and once paid does away with battery expenses for quite a long while.

The author is aware that not so very long ago there was a lot of comment about the recharging possibilities of alkaline types, but in spite of quite a bit of experimentation and the measurement of the "charge" and discharge characteristics under a number of conditions, the results obtained were, at best, inconsistent and dubious. Perhaps I was doing something wrong, but at the end of it I felt there was little to be usefully gained from trying to resuscitate flat alkaline cells when proper rechargeables were readily available. Let me add that this is purely a personal view based on my own experiments; others may have been more successful.

This article describes a simple NiCad charger which will do the necessary charging when required and costs no more than the cells themselves.

NiCad cells come in several forms: sintered cells, high-temperature cells and the so-called mass plate cells. The general purpose sintered types have very low internal resistance and so are capable of large discharge currents; they also come in equivalent physical sizes to the popular non-rechargeable types, that is, the AA, AAA, C, D, and PP3 varieties.

They also have shelf lives for periods up to 5 years without the necessity of periodic recharging to maintain their efficiency and performance. Normally, when such cells are bought, they have only a residual charge and so must be fully charged before being put into use.



CELL CAPACITY

Unlike, for example, lead acid batteries, NiCad cells should be charged from a *constant current* supply. For the standard sintered types the normal charge rate is about one-tenth (0·1) of the nominal cell capacity (*C*) which is stated in ampere-hours (Ah), this being the product of the discharge current and the time of use.

Thus, for an AA cell of 0·5Ah capacity, a charging current of 0·05A or 50mA is needed. At this rate the cell will be fully charged in a period of about 15 hours, that is, when a charge equivalent of 150 per cent of the Ah capacity has been returned to the unit.

If a cell is not completely discharged after a period of use, a shorter charging period is acceptable but, in general terms, no damage is likely to result if the cells are charged by up to twice the recommended rate. Higher rates can be used to reduce the charging time but for rates greater than the discharge current (0·5A for the AA example above where the charge would be completed in one hour) it is best if the cell has been allowed fully to discharge prior to the recharge.

Taking an overall view, the best efficiency is obtained if the cells are completely discharged from time to time and then recharged without an intervening shelf storage period. The general relationship between charge rate given in terms of the cell capacity *C* and the charge time is shown in the graph of Fig 1. Log scales have been used to accommodate the wide range of the variables.

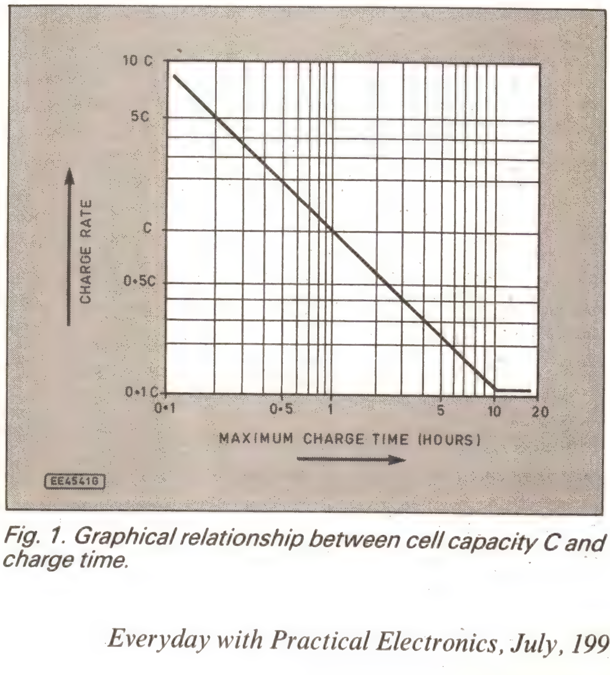


Fig. 1. Graphical relationship between cell capacity C and charge time.

CIRCUIT PRINCIPLES

A source of constant current has a high output resistance, unlike a constant voltage source which has a low output resistance. However, if we make use of a constant voltage supply and connect this to a constant load resistance, the current flowing will also be constant.

The basic circuit of such a device is shown in Fig. 2. This employs a constant voltage i.c. from the popular 78xx regulator series, and a load resistor R_1 connected across the two points A and B between which the constant voltage (V_{ref}) is normally developed. If the *variable* loading, represented by the cell being charged, is now connected in series with the output of this circuit, the current I_0 will still remain constant and the proper charging requirement will be obtained.

The value of R_1 will determine the actual charging rate, that is, R_1 is selected (or adjusted) so that the desired current

$$I_0 = \frac{\text{basic regulator voltage}}{R_1} + I_1$$

For the 7805 chip, $V_{ref} = 5$V and I_1 is approximately 5mA.

This makes R_1 about 110 ohms for a 50mA constant I_0. In a practical circuit, R_1 may be adjustable so that I_0 can be made to suit different charging rates.

The input voltage V_i is of course derived from a transformer, rectifier and smoothing system in a conventional "power unit" style.

PRACTICAL CIRCUIT

The actual Simple NiCad Cell Charger described here is a simple modification of the above basic circuit, and is shown in Fig. 3. Transformer T1 has a total 12V r.m.s. secondary rated at 0·5A (6VA) and this enables a peak d.c. voltage of about 16V to be developed across capacitor C1 after rectification by the "bridge rectifier" diodes D2 to D5.

This provides the input to IC1, the 7805 regulator, and allows up to four cells of AA, AAA, C and D types, or a PP3 battery, to be charged. The basic circuit has the addition of protective diode D1 shunting the 7805 and the inclusion of a red l.e.d. D6 in the common connection to act as an indicator that charging is actually taking place.

The voltage drop across a l.e.d. is typically about 1·5V to 1·8V; taking an average of 1·65V, V_0 is then $(5 + 1{\cdot}65) = 6{\cdot}65$V and hence:

$$I_0 \simeq \frac{6{\cdot}65}{\text{VR1}} + I_{\text{l.e.d.}}$$

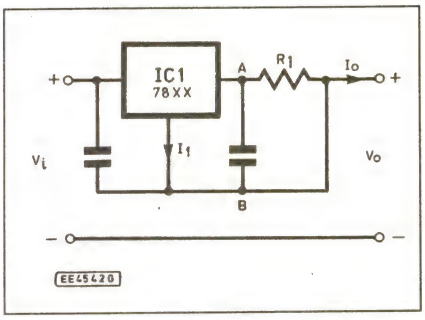


Fig. 2. The basic constant current generator.

This differs from the previous estimate a little but, as mentioned before, the required current is best set (for the purist!) by selecting the right value of resistor, hence preset potentiometer *VR1* is introduced.

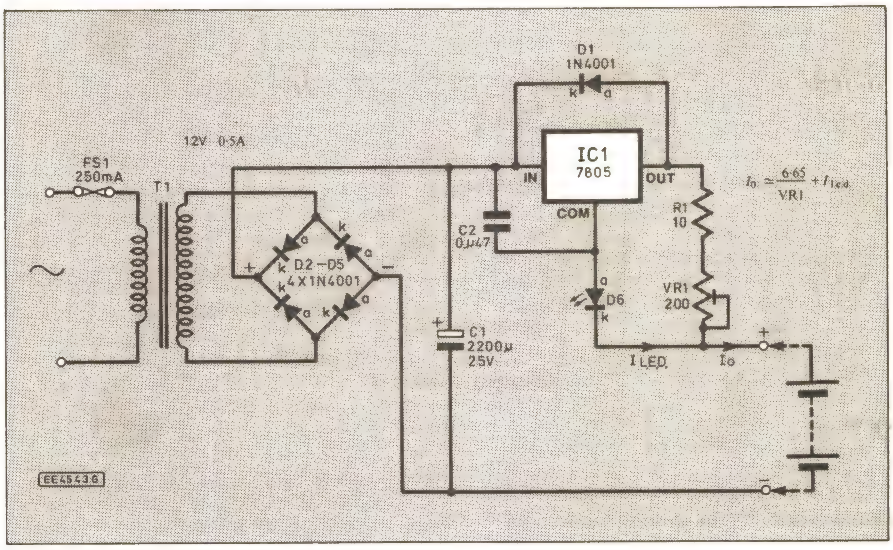


Fig. 3. Complete circuit diagram of the Simple NiCad Cell Charger. See text for changes to the value of resistor R1 for PP3 cell charging.

COMPONENTS

See SHOP TALK Page

Resistors

R1	10
0·5W 5% carbon	

Potentiometer

VR1	200 rotary wirewound

Capacitors

C1	2200μ axial elect. 25V
C2	0μ47 min. polyester layer, 100V

Semiconductors

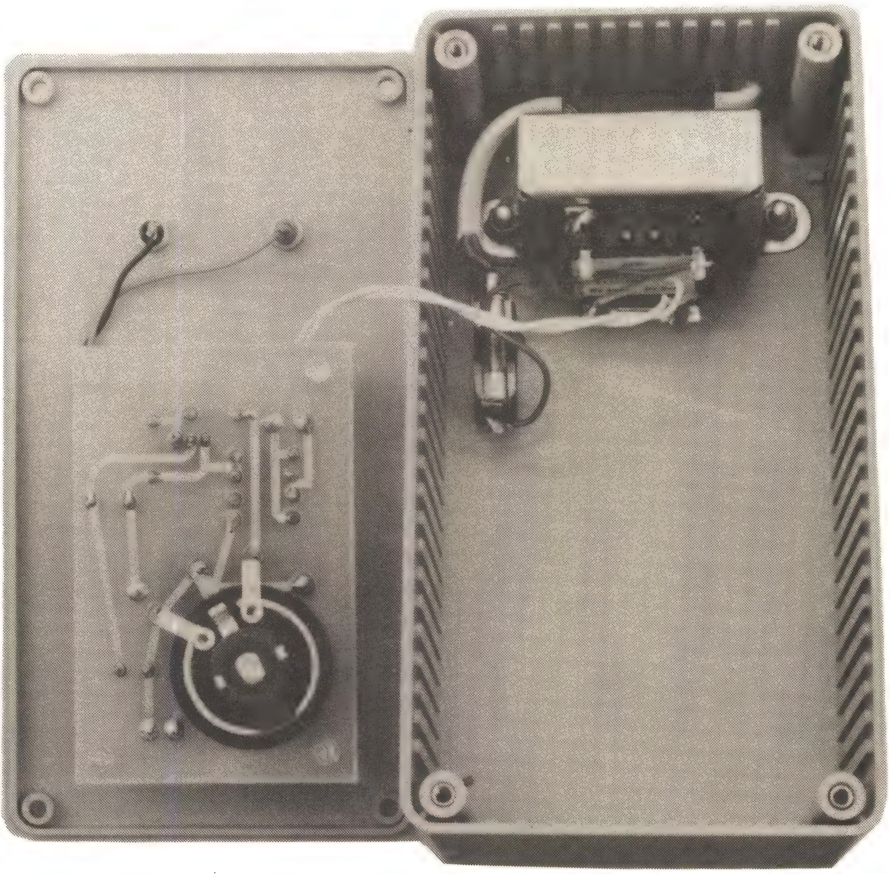
D1 to D5	1N4001 1A 50V rect. diode (5 off)
D6	standard red l.e.d. and clip
IC1	7805 +5V regulator

Miscellaneous

T1	mains transformer; primary: 240V a.c. secondary: 12V or 6V-0V-6V
FS1	250mA 20mm fuse and fuseholder

Printed circuit board available from the *EPE PCB Service*, code 884; ABS plastic case, size 150mm x 80mm x 50mm; red and black (blue) output terminal post; rubber grommet, 6·4mm (¼in.); spacers (4 off); multistrand connecting wire; solder etc.

Approx cost guidance only **£12** *excluding case*



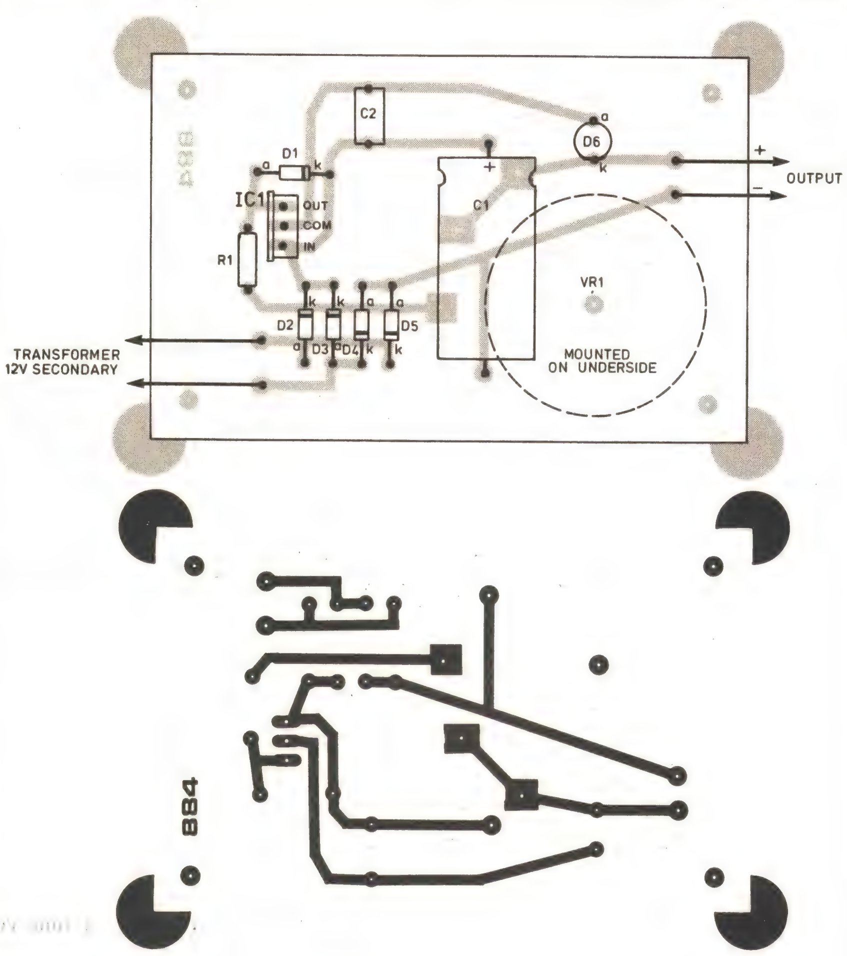
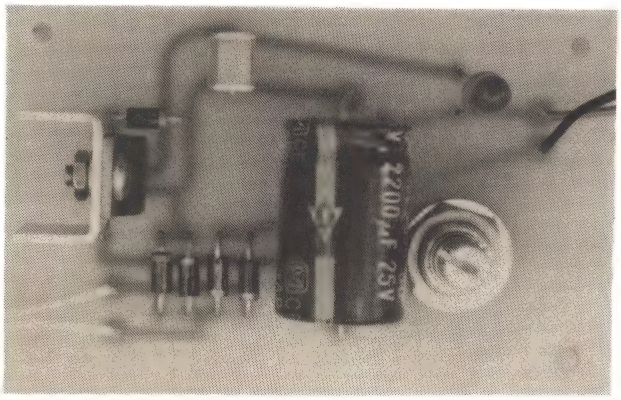
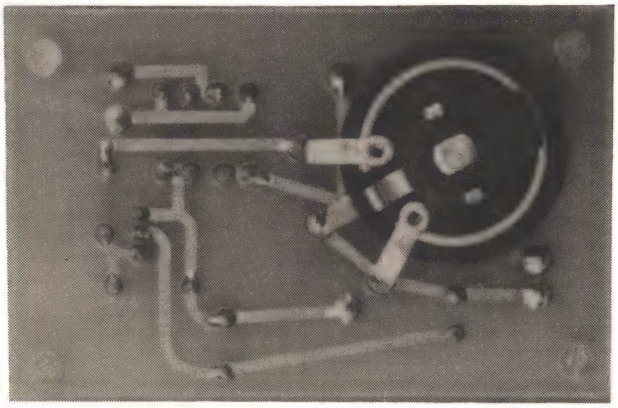


Fig. 4. Printed circuit board component layout and full size underside copper foil master pattern.



Topside component layout showing the small heatsink bolted to the metal tab of the voltage regulator.



Trackside view of the p.c.b. showing the control tags soldered directly onto the copper pads.

CONSTRUCTION

With the exception of the mains transformer, the charger is assembled on a small printed circuit board (p.c.b.) and this is mounted on the inside of the lid of an ABS plastic box measuring 150mm × 80mm × 50mm, though any alternative box which will comfortably accommodate the board and the transformer in the same way may be used. The p.c.b. is available from the *EPE PCB Service*, code 884.

The board topside component layout and full size underside copper track master pattern are shown in Fig. 4, and there should be no problems in assembling this. Notice particularly that the current control VR1 is mounted on the *copper* side of the board, its three tag terminals being bent slightly at their extremities so that they can be soldered directly on to the large square copper pads.

A small heatsink (though not strictly required) is also bent out of a piece of 16s.w.g. aluminium measuring about 25mm × 12·5mm (1in. × ½in.) and attached with a single screw and nut to the 7805 regular chip metal tab – see photo.

Before assembling the components on the board, use it as a template for positioning its four corner fixing holes, the position of VR1 and the l.e.d. on to the lid of the box. The board position for doing this is shown in broken lines in Fig. 5 which is a top view of the lid with the position of the two voltage output terminals also indicated. Now drill out the lid holes to the sizes indicated, putting a ¼ inch grommet in the hole for VR1 adjustment and a l.e.d. clip in the other hole.

The board can now be assembled, taking care over orientation of the diodes, the 7805 regulator IC1 and capacitor C1. Push the l.e.d. into its mounting hole (correctly orientated!) but *do not* solder this component for the time being.

ASSEMBLY

The completed board is now fitted to the underside of the lid using four 22mm (7/8in.) spacers (or long screws will do) as shown in Fig. 6. The slot in the spindle of VR1 should now be just behind the grommetted hole so that it can be adjusted with a small screwdriver or trimming tool through this hole.

A panel knob has not been provided for this control to avoid accidental movement during a charge period. If you wish, you can put an extension on to the spindle to bring it out through the panel hole and attach a suitable knob.

Once the board is secured, the l.e.d. can *then* be edged upwards to slide into its panel clip and its leads finally soldered to the copper pads. To complete this part of the job, two leads are taken from the current output pads to the output terminals; 1mm sockets were used on the prototype but any small and appropriately coloured posts may be used here. Solder also two other leads from the a.c. input pads on the board for connection to the mains transformer secondary; about 130mm (5in.) lengths are adequate.

TRANSFORMER AND FUSE MOUNTING

The transformer and base-mounting type fuseholder are mounted in the base of the box at the end away from the p.c.b. and a twin power input lead is brought out through a suitable hole located in the end

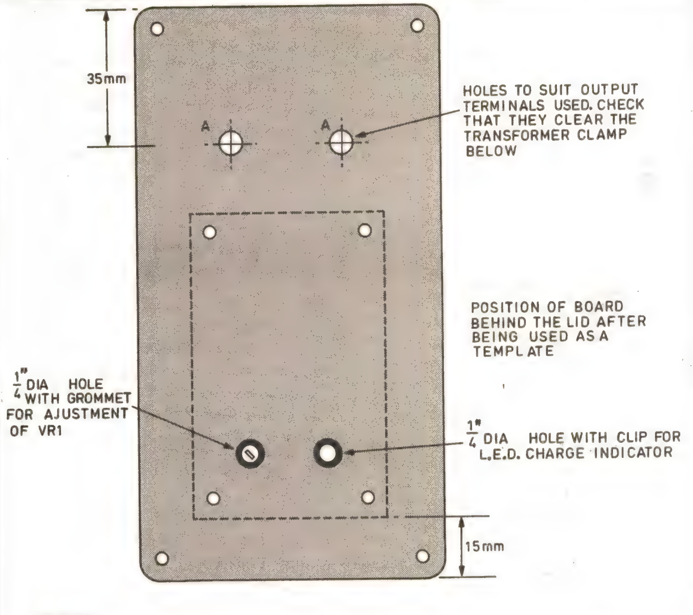

35mm
A
A
HOLES TO SUIT OUTPUT TERMINALS USED. CHECK THAT THEY CLEAR THE TRANSFORMER CLAMP BELOW
POSITION OF BOARD BEHIND THE LID AFTER BEING USED AS A TEMPLATE
1/4" DIA HOLE WITH GROMMET FOR AJUSTMENT OF VR1
1/4" DIA HOLE WITH CLIP FOR L.E.D. CHARGE INDICATOR
15mm
EE4545G

Fig. 5. Lid drilling details and position of the p.c.b. under the lid. Exact positions not critical.

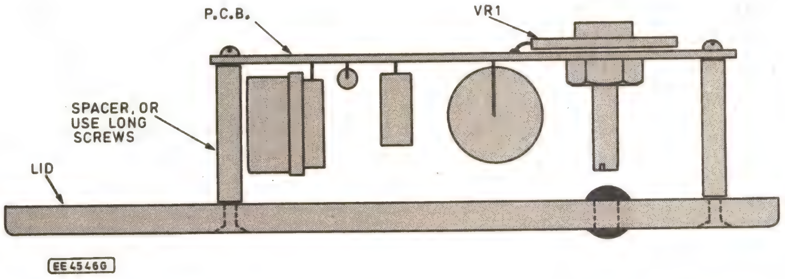


Fig. 6. Suggested method of mounting the p.c.b. to the underside of the case lid.

wall of the box. Care must be exercised here to ensure that there can be no possibility of contact between the tags on the fuseholder and the transformer clamp or secondary outputs.

Make sure that the power lead is adequately anchored inside the box so that no strain can be placed on the internal connections from outside. No on-off switch has been incorporated as the charger is normally used for an extended period and can be plugged into a suitable point when required. The l.e.d. charging indicator acts as a warning that the unit is switched on, but note that this applies *only* when cells are actually being charged.

Once the transformer and fuseholder (with a 250mA fuse) are mounted satisfactorily, the a.c. input leads from the p.c.b. can be soldered to the secondary (12V) tags and the lid of the box screwed in position.

USING THE CHARGER

All cells should be charged in *series* and up to four of each type can be accommodated. Do not *mix* the *types* of cell in any one charging operation.

A slight modification is needed if you are habitually charging PP3 batteries. A total value of about 500 ohm is needed for VR1 to reduce the charging current to the required 11mA in this case, and a resistor of 270 to 330 ohm value should be wired in series with VR1.

Table 1: Charging Currents

Cell Type	Capacity	Charge current
AAA (RX3)	180mAh	18mA
AA (RX6)	500mAh	50mA
HP11 (RX14)	1·2Ah	120mA
HP2 (RX20)	1·2Ah	120mA
PP3	110mAh	11mA

The charging current for PP3 batteries can then be checked with a suitable meter to set things as close as possible to 11mA (which is not critical as such), using VR1 as a final trimmer. This resistor could be put in place of the existing R1 to avoid board changes, but it would have to be shorted out when other types were being charged.

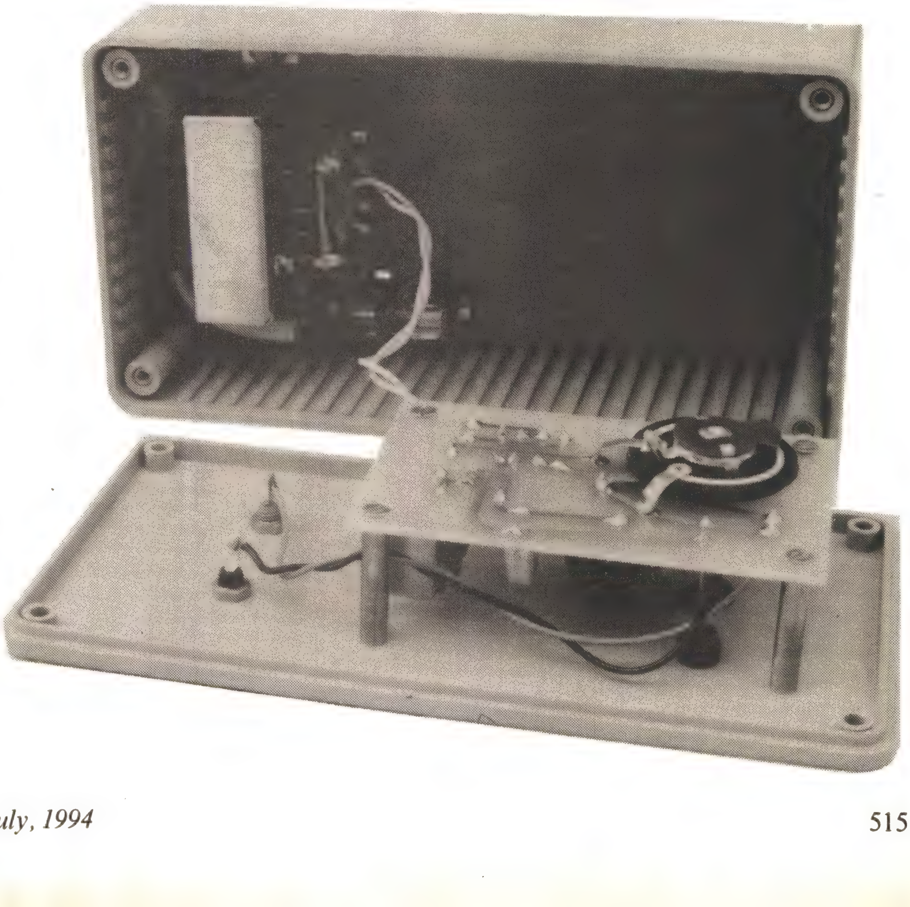
The charging indication provided by the l.e.d. D6 will normally light quite brightly for cell charging but will be dim when a PP3 is being charged. This is quite normal and does not indicate that the battery is not being charged.

Remembering that this project is in its most basic (and cheapest) form, there is a lot of opportunity of making your own modifications and additions if you are that way inclined. For example, a meter can be added in series with the positive output lead, with a f.s.d. of, say, 250mA, to monitor the charging current. A cheap edgewise type would be suitable and you would probably have to shunt it to provide the range needed.

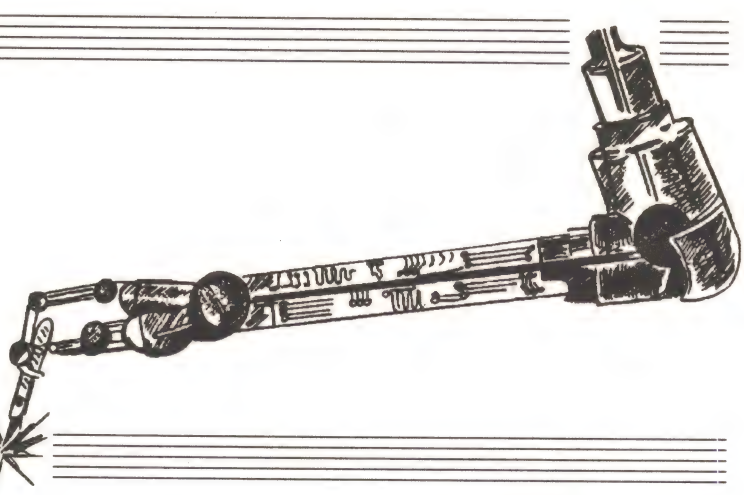
Also, up to ten cells at a time could be charged by replacing the present mains transformer with one having a total 24V (or 12V-0V-12V) secondary rated at 0·5A. Capacitor C1 would have to be uprated to 35V to 50V working but nothing else need be affected.

Table 1 indicates the different cells which can be charged on this unit. with the nominal charging currents. The charging times at these rates is about 15 hours for all types. □

(Below) The completed charger showing the p.c.b. mounted on the lid using stand-off spacers.



Regular Clinic



CIRCUIT SURGERY

ALAN WINSTANLEY

This month in our "customer clinic" we suggest a test probe for checking car electrical wiring, also model railroad sound effects and advice on 555 triggering methods. We also ask,* Ingenuity Unlimited *– should it make a comeback?

555 Triggers

Mr. Kenneth Yeo of Glasgow requests help with methods of triggering the immortal 555 timer i.c.

I'm a bit puzzled as to the method of triggering the 555 timer chip, especially in monostable mode. Does it need to be momentary, and how do you implement it in practice? Please explain in your column whenever appropriate.

The monostable mode Mr. Yeo referred to, involves the 555 timer i.c. delivering a single timed pulse, see Fig. 1a. The monostable is sometimes called a "one shot" for obvious reasons.

To start timing, it requires a suitable trigger signal at pin 2, equivalent to ***one-third or less*** of the supply rail voltage. If pin 2 is ***higher*** than this level, then either the device remains reset, or if it's already timing, it will time out in the normal way after the period ends. During timing, the 555 ignores any further trigger signals – so it's a *non-retriggerable* timer.

However, not only is the trigger voltage important, but also the trigger ***duration*** as well. Mr. Yeo is right – the trigger period *does* need to be "momentary" in that it must always be shorter than the timing period of the i.c. Otherwise the 555 continues to time or "runs on," and it will only reset itself once the trigger voltage rises above 1/3 the supply rail, when the chip resets as soon as the trigger is removed.

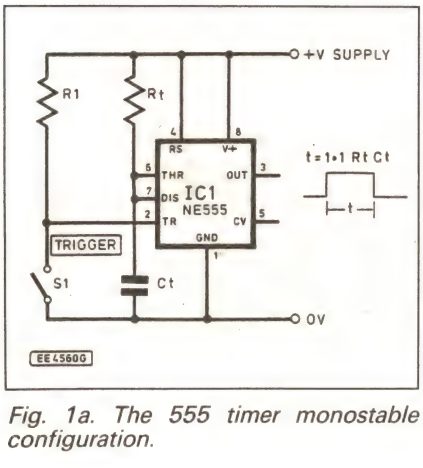


Fig. 1a. The 555 timer monostable configuration.

A simple mechanical means of triggering is to use a pull-up resistor R1, anything from say 22 kilohm to 100 kilohm should suffice and this biases the trigger to the positive rail to avoid any false starts. Closing S1 sends pin 2 to less than one-third (0V in this example) of the rail voltage so timing will commence. The output pin (3) of the 555 goes high to almost the supply voltage, for a period equivalent to roughly 1·1 R_tC_t seconds, where R_t is in ohms and C_t is in farads.

R-Cee

Alternatively, it's possible to add an *RC* network to the trigger pin so that the 555 starts timing immediately upon power up, see Fig. 1b. Pin 2 is pulled down to 0V initially and rises progressively towards the positive rail.

The trigger time constant (*RC* seconds) should be short enough to ensure that the voltage on the trigger pin rises above *one-third* of the supply rail before the time period is due to finish, to avoid run-on. Calculate values so that $RC < 1{\cdot}1\ R_tC_t$. That way, the trigger pin voltage will safely reach nearly two-thirds of the supply rail voltage before the monostable times out. Useful as a power-on single pulse generator or similar.

You can trigger the timer using external TTL or CMOS gates or, say, transistor systems to generate a suitable trigger pulse. It's worth pointing out that unlike the trigger pin, the *reset* terminal (pin 4) requires a voltage of no more than 0·7V or so in order to reset the monostable period. Mr. Yeo also asked for advice on choosing the right capacitor for particular applications – something I'll try to tackle next month.

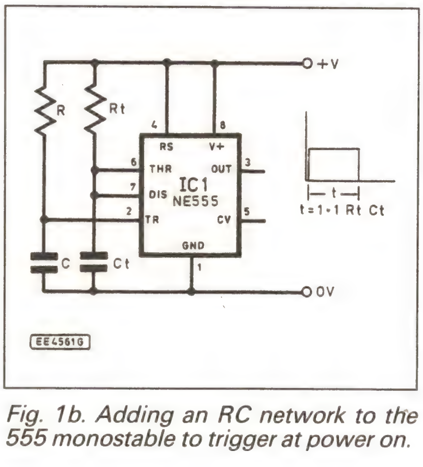


Fig. 1b. Adding an RC network to the 555 monostable to trigger at power on.

Car Electrics Probe

A keen auto electrician, ***Mr. Robert Allison*** of Falkirk has just started in electronics and requests a simple device to help investigate car electrical systems:

Having seen a commercial type costing some £80, is there a cheaper way of doing it? Mr. Allison asks.

A Car Electrics Probe which will help you to discriminate between "live" wires (+12V) and 0V connections, and also perform basic continuity tests, is shown in Fig. 2.

For simplicity I opted for a 555 astable multivibrator which is powered from the vehicle's battery and drives a bi-colour l.e.d. This alternates between Red and Green under open circuit (no connection) conditions, acting as a "standby" indicator. A 12V input lights the Green l.e.d. whilst a 0V connection illuminates the Red l.e.d. instead.

The probe input is taken via resistor R1 to the trigger pin (2) of the i.c.; with no input connection, the astable runs freely and the l.e.d. blinks both colours. A 0V input provides an overriding trigger signal which causes a high output, so D5 (red) lights. A +12V input disables the trigger so the green l.e.d. lights instead.

An "auxiliary" test lead connects directly to the reset terminal, to help with continuity tests when checking out leads, suspect bulbs, fuses, etc. Shorting the "AUX." terminal to the Probe input (i.e. continuity) will shunt the trigger pin towards +12V so the green l.e.d. illuminates.

In the case of a lack of continuity (open circuit), the l.e.d. will flash alternate colours. Actually, a resistance of up to one megohm is classed as "continuity", which is fine for simple go-no-go tests but it does have limitations. Operation is summarised in Table 1.

The Car Electrics Probe is powered from the car battery via the bridge rectifier D1-D4, which means that it doesn't matter which way round the device is connected to the battery. Two crocodile clips can be used on a generous length of twin-core cable for the power supply input, a third croc. clip could be employed for the AUX. input, or use a small socket to connect a test lead instead, for continuity checks.

The circuit could be built on stripboard and housed in a suitable probe case (e.g. Maplin JX57M which is fitted with a metal test prod): the voltage at the tip then determines the colour of the l.e.d. It's important that a "back-to-back" bi-colour l.e.d. is utilised, these have only *two* leads. The common-cathode type l.e.d. having *three* leads is unsuitable.

An alternatively would be to use two individual light-emitting diodes. By reducing capacitor C2 to say 10nF, the bi-colour l.e.d. will glow *orange* (i.e. high frequency red and green) in the "standby" mode.

Some final tips when working on vehicle electrics – beware a metal watch strap shorting across the battery and burning your wrist, also avoid creating sparks near the battery because of the potential explosion hazard (hydrogen gas in the battery). It's safest to cover the battery with a damp cloth for protection when performing electrical tests nearby.

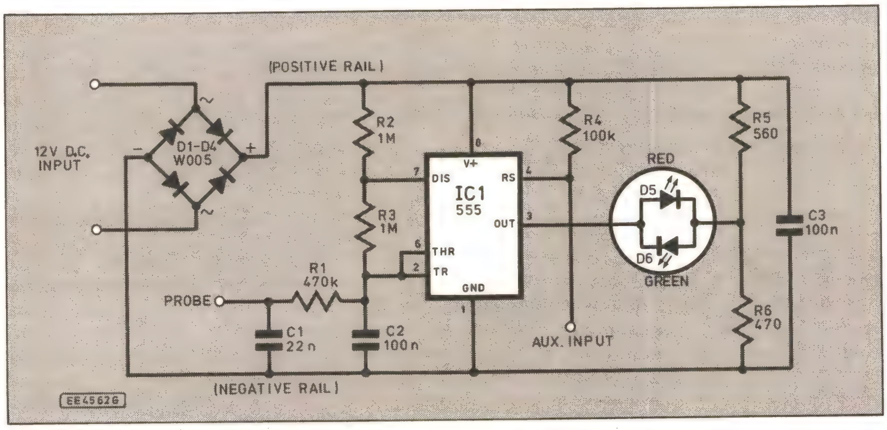


Fig. 2. Circuit diagram for a simple Car Electrics Probe.

Table 1: Test Results

Probe	Aux. Input	L.E.D. Display
0V/ Chassis	N/A	Red
+12V	Continuity with tip	Green
Open Circuit	Open Circuit	Green/Red Alternately

COMPONENTS

Car Electrics Probe

Resistors

See SHOP TALK Page

R1	470k
R2, R3	1M (2 off)
R4	100k
R5	560
R6	470

All ¼W 5% carbon film

Capacitors

C1	22nF polyester
C2, C3	100nF polyester (2 off)

Semiconductors

D1-D4	W005 50V 1·5A bridge rectifier
D5/D6	bi-colour l.e.d.
IC1	NE555 timer i.c.

Miscellaneous

Stripboard; probe case; twin-core wire; crocodile clips (3 off); solder etc.

Approx cost guidance only **£5** including case

Train Effects

You can have some great fun with a new range of sound effects chips supplied by **Greenweld (☎ *0703 236363*).** They're based upon "chip-on-board" (COB) i.c.s which have the chip mounted onto a small p.c.b. protected with a blob of resin, rather than embedded within a dual-in-line package. Connections are made by soldering directly to pads on the board.

I tried their "Train FX" chip when reader ***K. Hall*** of Coventry asked me for a twin-tone train effect to fit within a model locomotive – unfortunately a sound which the (Americanised) FX chip couldn't emulate. I doubted that a speaker would fit into a model loco. anyway due to lack of space, and a small piezo sounder would probably be ineffective.

An application circuit which generates four different sounds upon closing the appropriate switch is shown in Fig. 3. The clanging level crossing bell and "diddly dum" of train rolling stock reproduced particularly well.

I used a Darlington (TR1) to drive an 8 ohm 64mm (2·5in.) dia. speaker directly. Part types aren't critical and battery consumption is low – you could build several units and place them strategically on your layout. Trigger by selecting a reed switch, activated by a magnet placed underneath a passing train.

That bell effect could also make a novel and effective alarm tone generator. Other sound effects chips are available in the range, see the Greenweld advertisement.

That cap.

Mr. Peter Falconer of Basingstoke supplied some further information on that mysterious mica capacitor shown in Fig. 1(d) of May's *Circuit Surgery*, the markings of which don't seem to comply with any common code.

The top value of the component, 300J, ***does*** *mean a 30pF type with five per cent tolerance. The bottom value shown is obviously the working voltage of 100V. The middle number is a type number, not the value of the component.*

The N750 type mica capacitor is available at Tandy stores as part of a kit (their reference no. 272-801) which contains a variety of capacitor types. As for the 30pF value not being standard, I assume it's an approximation of the value.

Thanks for your letter. Our original correspondent on this matter did actually tell me in his letter that he bought the capacitors from a Tandy retail store – worth browsing in for some unusual or interesting components which you don't always see in the mail order catalogues.

Aquarium thermostat

From South Africa came an enquiry concerning one of my own constructional projects, the *Pond Heater Thermostat* (EPE Jan. '94). This senses the ambient air temperature and turns on a floating heater element when the temperature approaches freezing point, so creating an essential breathing hole for pond fish during icy weather.

Mr. Andrew Clark of Transvaal asks:

I'd like to adapt your Pond Heater Thermostat *design for use indoors as an aquarium thermostat, operating between 24 to 30 degrees Celsius. The LM3911 i.c. is capable of handling this range. Your circuit and p.c.b. monitor the air temperature, but can it be adapted for measuring water temperature instead?*

Yes it can – simply mount the i.c. on a small piece of stripboard and connect to the main p.c.b. using flying leads (or 4-way cable). Then house the entire i.c. sub-assembly in a ***completely waterproof*** enclosure, e.g. a glass phial sealed with silicone rubber, which is then submerged in the aquarium. The multi-turn preset is fine for setting a temperature suitable for tropical fish.

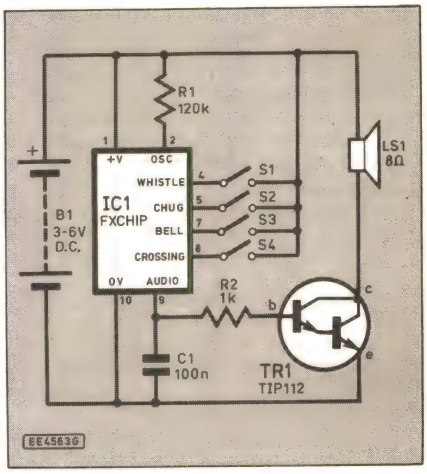


Fig. 3. Train Sound Effects circuit using the "chip-on-board" i.c.

However, you will perceive a small degree of relay "chatter" – say half a second or so of a buzzing sound – because the circuit does not have any hysteresis and therefore is liable to jitter slightly at the temperature set point, just when it's switching on or off. This chatter may be a bit irritating in a domestic environment!

However, the circuit is likely to be much more reliable and controllable than an ordinary bi-metallic thermostat. It could also be adapted for other temperature control applications in photography, home brewing perhaps, honey making (ask an apiarist), or horticulture.

Ingenuity Unlimited

Robert Baker suggested a way we could accommodate readers' own circuits on our pages. *Circuit Surgery* isn't the ideal vehicle for this, being devoted more to general queries and problems. Hands up all former *Practical Electronics* readers who remember the *Ingenuity Unlimited* feature!

It was the "must-read" column for *PE* fans, crammed full of readers' own circuit suggestions to share with fellow hobbyists and enthusiasts. Well, we never forget that this is ***your*** magazine and so the Editorial team wants to know what ***you*** think about re-introducing this immensely popular feature.

Ingenuity Unlimited was also a good proving ground for budding designers. It was precisely that feature which nearly twenty years ago stimulated my own modest interest in writing for *Everyday Electronics* as a schoolboy.

Certain strict ground rules had to be implemented following several incidents perpetrated by a minority of readers (from both home and overseas). The same rules would apply today: specifically, all circuit designs ***must*** be entirely the reader's own work, and must not have been submitted for publication elsewhere. Strictly no copying from magazines or books because we or our loyal readers invariably spot this.

Potential submissions would also need to be neatly drawn and written, preferably typed. No correspondence would normally be entered into, though we would pay between £10 and £50 for the best circuits published. In truth the reaction to my request for your best "Hints and Tips" has been disappointing – so it's over to you, readers – nothing can happen unless we know how you feel so tell us what you think!

If you would like to see the return of *Ingenuity Unlimited*, tell us by writing to *Circuit Surgery*. We look forward to hearing your views.

Next Month: One or two reader's own circuits and a suggestion for a battery back-up for powering marine equipment. Don't forget our service to education supporting GCSE and GCE "A" Level Electronics Syllabuses and similar.

If you have any questions, problems or suggestions for possible inclusion in this column, please write to me: Alan Winstanley, *Circuit Surgery*, 6, Church Street, Wimborne, Dorset, BH21 1JH. I regret I cannot guarantee to reply to every letter but will endeavour to offer advice wherever possible.

SHOP TALK

with David Barrington

Space is at a premium this month, so we shall start off our "components round-up" by pointing out that prices and codes for ordering all p.c.b.s used in this month's projects appear on page 555.

Voxbox

The only source we have found for the special direct analogue storage, voice recorder i.c. type ISD1020AP used in the *Voxbox Voice Recording Board* is from **Maplin**, code KU66W. The 38mm dia. speaker also came from the same supplier.

Searching for the AD2950 low power regulator, we only came up with the name **Farnell**. As our catalogue is now completely out date, we suggest you give them a ring on 0532 636311 for a price.

If difficulties are experienced locating suitable pushbutton switches, they came from **Electromail**, codes 337-605 (blue) and 337-598 (red).

Simple NiCad Charger

As the printed circuit board for the *Simple NiCad Charger* is so small, the selection of the potentiometer must be made with this in mind. The "pot" is mounted and soldered directly on the board.

The one used in the model is intended for loudspeaker volume controls, is rated at 3·5W and was purchased from **Maplin**, code FX99H. Other alternatives may be used but they may not fit on the p.c.b.

Watering Wizard

The two major requirements for the *Watering Wizard* are the solenoid water valve and the clock movement. The low voltage solenoid valve was purchased from **Electromail** (☎ *0536 204555*), code 342-023, and the chiming clock movement from **Maplin**, code YU66W (Melody Clock). The mains transformer (WB10L) and the fluid level detector LM1830 i.c. (code YY99H) were also obtained from the latter source.

The TIP120 Darlington transistor is currently listed by **Cricklewood** (☎ *081 452 0161*) and **Greenweld** (see right). You could also use the TIP121 and TIP122 Darlingtons in this circuit. The MPSA14 Darlington is stocked by **Cricklewood, Greenweld** and **Maplin**. The ZN1034E precision timer seems to be fairly widely available.

When ordering the 2·1mm power socket, make sure it is the plastic bodied type with fully insulated terminals. Also, take particular care to solder and secure the Earth lead and use only mains type, rated at 3A minimum, wiring where indicated.

Print Timer

The main concern to be confronted when buying components for the *Print Timer* is, will they all fit in the **Maplin** pocket size case (code KC95D). The "piano" style 8-way d.i.l. switch was also bought from them, code JW76H.

The red and blue button switches came from **Farnell** (☎ *0532 636311*), codes 146-202 and 146-205. Other p.c.b. mounting switches can be used here, but check that contact layout is the same and that they are low-profile types. The small presets came from the same company, code 108-241.

Stereo HiFi Controller

Looking down the list of parts for the *Power Supply Unit* for the *Stereo HiFi Controller* project, all items appear to be standard lines and should not prove too difficult to locate.

However in case any problems do arise, the metal instrument case used in the prototype came from **Maplin**, code XJ25C. The p.c.b. connectors also comes from the same source and came in three parts: the plug assembly (BX96E – 3-way); the socket housing (BX97F – 3-way) and terminal strip (YW25C). The 2-way version is coded RK65V and HB59P respectively.

Circuit Surgery

Looking at this month's *Circuit Surgery* everything should be straightforward. The l.e.d. used in the Car Electrics Probe is a *two-lead* bi-colour type, such as the Maplin QY38 or similar. They also list a probe case (JX57M) which could be adapted for use here.

The Train Sound Effects chip is only available from Greenweld and is from their "chip-on-board" collection, code SG1. They are currently running a special offer to EPE readers of "buy four COB chips and receive the SG7 Free!" – see their advertisement on this page. Also, they are only charging £1 p&p for any goods ordered from this ad.

SOUND EFFECTS

(see Circuit Surgery on page 516 of this issue)

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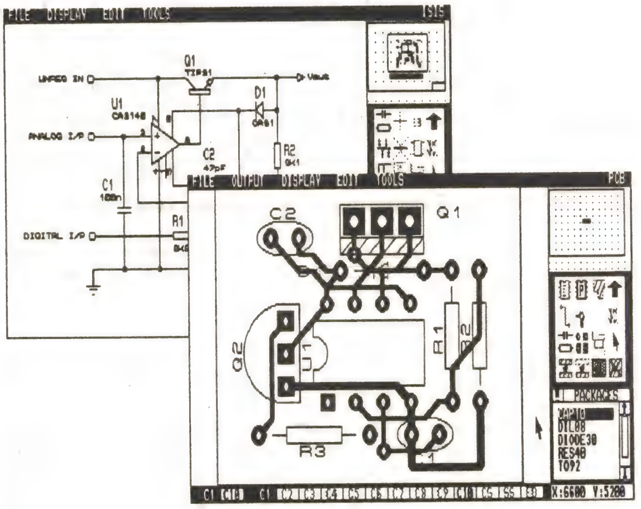

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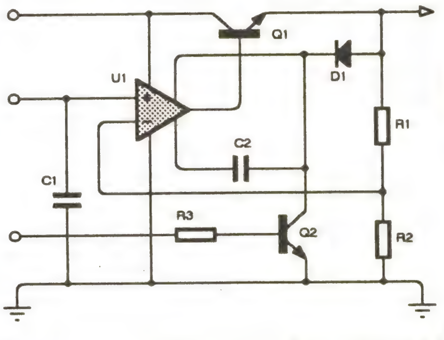

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Where is Britain's place in the world scene?

In this article about the British electronics industry we shall spend some time looking at the independent education service and suppliers of electronic components and equipment for amateur and educational use.

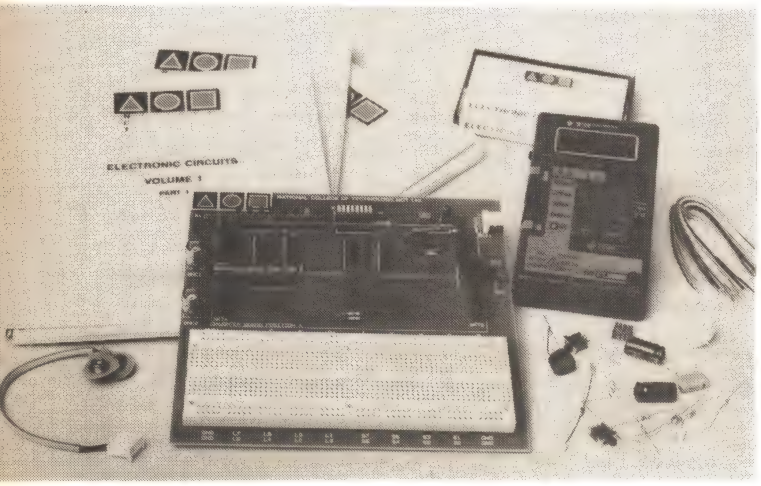
At one time it was difficult finding someone with a qualification in *electronics* as such. Electronics was seen as an extension of electrical work. Many saw it simply as a craft skill. Some saw it as a branch of physics. Today, with the enormous advances and sophistication in electronics there is a whole range of qualifications to be gained in the subject.

At starting level in schools and colleges, *GCSE Electronics* offered by a number of examinations boards provides an excellent foundation in the subject. This may lead the student to an AS Level or A-Level. School Technology also introduces electronic systems as a means of problem-solving.

Even so, most students leave secondary school without having obtained – or had the chance of obtaining – an electronics qualification. For such people, there are evening class courses leading to GCSE and BTEC certificates and there are courses laid on by employers and independent organisations.

At a distance

Many prospective students live some distance from their nearest evening class centre. After a hard day at work, many would prefer to study at their own pace at home. For such students, the ***National College of Technology*** (NCT) was established in 1986 with the aim of providing adults with a BTEC qualification.



Some of the components that go to make up the Electronic Circuits Volume 1 course from NCT.

The Business Technician and Education Council (BTEC) has recognised that there are many people who wish to develop a new skill but who, for various reasons, have been unable to do so. They have therefore created a system of approved courses operated by various bodies. NCT provide a range of BTEC approved "distance learning" courses. These are biased towards practical work and can be started at any level. These courses are also appropriate for industrial training where full technical support and course administration is provided by the college.

Privately-entered students are offered a Tutor Support Service and most take this up. A student cannot predict when he or she will find difficulty and with a tutor available on the other end of the phone, help may be obtained at any time whether in the evenings, weekends or holidays. Each course operated by NCT is periodically inspected by the BTEC authority and although registration for BTEC is optional, 99 per cent of all students do opt for it.

Some courses require no previous experience – these are referred to as *Volume One* courses – and are suitable for complete beginners or those whose knowledge is rusty or out of date. A few examples from the range are listed presently – the cost of each is £199. The Tutor Service costs £29.50. Tutor Support with BTEC registration costs an additional £51.

Each course provides a self-contained pack of workbooks, audio cassette with mini-lectures, circuit boards, instruments, tools, components and leads. As the student moves through the courses a comprehensive work station is built up since the hardware used for a Volume 1 course moves forward to Volume 2 etc. If, through previous knowledge, a student wishes to begin at Volume 2 or 3 level, a start-up kit supplies these "brought forward" components.

Topics introduced by *Electronic Circuits Volume 1* include resistors, colour code, measuring instruments, Ohm's Law, the potentiometer, light dependent resistor (l.d.r.), etc. Power calculations and graph plotting for capacitor charge and discharge are also included. This course is designed for about 45 hours of study and the cost includes a digital meter. The photograph shows the materials supplied for the course.

Another 45 hour course, entitled *Fibres & Optoelectronics Volume 1,* introduces the fundamentals of fibre optics. This involves making a fibre optic link using tools supplied with the kit. The course covers much of the theory of optics – the electromagnetic spectrum, reflection, refraction, refractive index, critical angle, transmission losses, etc.

A further "no experience necessary" course is the *Digital Circuits Volume 1* package. Here topics include logic gates, combinational logic, truth tables and Boolean Algebra. Working systems are constructed on the p.c.b. provided. This is another 45 hour course with support cassette.

Success and Assessment

Success is measured in several ways. The student's work is divided into *workbooks* with a test paper at the end of each. The completed test papers are returned to the NCT tutor for assessment and a model solution provided.

From these, NCT can assess the student's ability to understand the technology and to appreciate his or her technical ability and standard of numeracy. From the cassette tape, it is possible to assess how the spoken word is understood and acted upon since answers are given by the student in response to questions.

Students having taken up the BTEC option must achieve 60 per cent minimum in each of the three tests referred to above to qualify for a certificate. These may be credited towards other BTEC composite certificates. The BTEC moderator will be involved in assessment by selecting students who he will either visit or ask for the workbooks to be submitted for scrutiny. In some courses, the assembled hardware is returned to NCT for examination.

Currently, NCT enrol between 900 and 1000 students annually with exported courses accounting for 10 to 15 per cent of total sales. Courses are being added, modified and updated all the time under the guidance of the writing teams. Students requiring up-to-date information should write to the college direct – their address is given at the end.

Smart move

The *Smart Box* manufactured by ***Economatics*** provides monitoring and control of systems using a PC, Apple Macintosh, Archimedes or BBC Model B computer.

Schools have been equipped with computers for many years. However, these are sometimes used only for computer studies, word-processing and for basic training in the use of spreadsheets, databases, and desktop publishing. Interfacing computers with sensors to monitor environmental changes (such as light level or temperature) and to use them to control a system (such as to operate a motor) has been somewhat slow to catch on. However, it is in the school environment – probably in Technology but also in Science – where much basic industrial training can be applied and this is where Smart Box could be useful.

The Microprofessor MPF-1B Z80 microprocessor training system from Flight Electronics.

It will accept the output from various analogue devices – such as light sensors – or digital ones such as a microswitch. It can then control devices such as lamps and motors. A simple serial cable is all that is required to connect the host computer. Smart Box uses its own Smart Move software. This is easy to understand by students and an example using it is given presently.

The cost of a Smart Box with software connecting pack and manual is £275. Sensors for temperature, light, position, sound and humidity detection are also available from the company – the cost of these varies between £15 and £35 depending on type.

An example of an application for Smart Box is to monitor the stability of a model bus. This gives a feel for the concept of centre of mass and how it relates to the stability of an object – useful in Science and Technology.

The model is placed on a platform which is then raised slowly by a motor (A). A pendulum sensor (Sensor 1) monitors the angle (Position) reached at any time. When the vehicle becomes unstable its upper wheels lift off a switch (Sensor 2). This triggers the Smart Box to record the position. A short time later, when the bus actually topples, it operates another switch (Sensor 3). Finally, the motor returns the platform to the point where a further switch (Sensor 4) operates – that is, back to the start.

The operation may be controlled by a procedure in Smart Move thus:

```
FORWARD A                   The platform tilts.
UNTIL SENSOR 2 IS ON        Until the first switch operates.
HALT A                      Then stops.
PRINT "UNSTABLE AT",
                 POSITION   The angle is recorded.
FORWARD A                   The platform continues to tilt.
UNTIL SENSOR 3 IS ON        Until the second switch operates.
HALT A                      Then stops.
PRINT "TOPPLED AT",
               POSITION     The angle is recorded.
BACKWARD A                  The platform returns
UNTIL; SENSOR 4 IS ON       To its original position.
HALT A                      Then stops.
PRINT "READY"               Ready for a further test.
```

Economatics supply other design and control materials. *Logicator* is a graphical design environment for computer control algorithms. With this, flow charts may be drawn and tested directly. This avoids any computing skills and allows the student to concentrate on the design process. An example of a problem given to a student would be to design a system to control a three-storey lift. This would respond to six sensors (a call button and a position sensor on each floor).

In flight

Flight Electronics specialise in the following areas: Training Systems, Interface and Control Cards, Breadboards, Test and Measuring Instruments, Tools and Books. They also organise courses.

The *Flight Microprofessor-1B* Z80 training system has been around for a number of years. With the Z80 microprocessor being so widely used, this training system is particularly popular and tens of thousands of units have been installed world-wide. This system provides an introduction to 8-bit microprocessors by the use of machine code instructions entered on a hexadecimal keypad.

The *Flight 86* provides training on the 8086 – probably the most widely-used 16-bit microprocessor in the world. It aims to teach all aspects of the 8086 and many of its commonly-used peripheral devices.

The *Transputer Trainer* is of particular interest. The transputer is a revolutionary type of microprocessor which differs from others in that any number of units may be connected together. Extremely powerful systems may therefore be custom-made to fulfil a given task.

In the field of industrial control, Flight produce such systems as a washing machine simulator and traffic control unit (to simulate the action of traffic lights and pedestrian crossings). They also supply a wide range of PC interface and control cards, breadboard systems and test and measuring instruments. These include bench power supplies, audio signal generators, logic analysers and sound level meters. They also supply a range of tools such as pliers, side cutters and so on.

Also on offer from Flight are 4-day intensive training courses. The fee includes the cost of hardware so this may be taken away by the student at the end. Examples of fees are: Z80 course, £770, 8086 course £740. The cost puts these courses out of reach of most amateurs. They are really intended for company staff who find themselves involved with microcomputer training or for industrial uses.

Flight publish a comprehensive catalogue and their address is given at the end for those who require further information. They are currently working on a new catalogue.

Technical Training

A wide range of technical training equipment is marketed by ***LJ Technical Systems.*** The *Digiac 3000* base unit consists of a student console with integral power supply, microprocessor board and network interfaces. Each study module consists of a circuit board which is loaded into the base unit. There is also a laboratory manual and storage case.

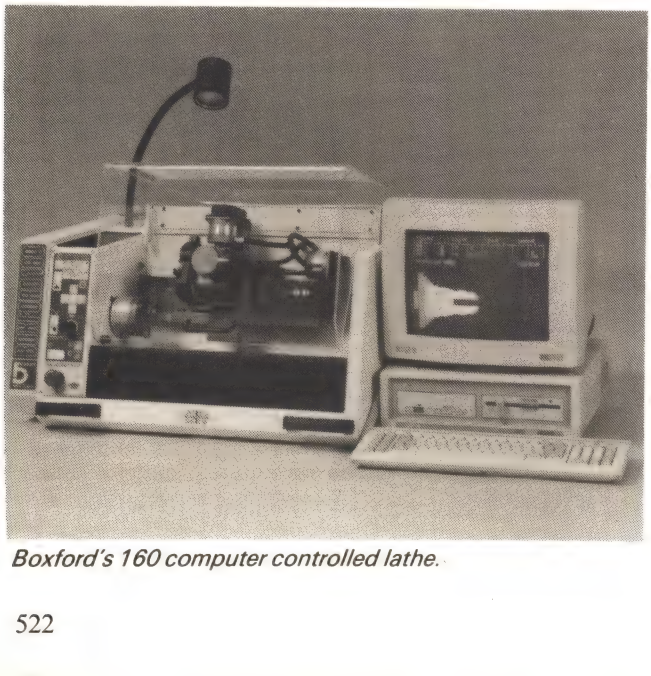
Examples of Digiac 3000 modules are: DC Circuits, Networks, Semiconductors, Optoelectronics, Power Supplies and Digital Logic. There are additional student laboratory manuals and theory workbooks. A full description of all modules is given in the catalogue which may be ordered direct – the address of LJ Technical Systems is given at the end.

The company provides many more training units covering Electricity and Electronics, Microprocessors, Control and Instrumentation, Programmable Control, Modern Communications, VCR and Computer Maintenance. They also organise short courses. Typical titles include: Introduction to Control Systems, Introduction to Digital Systems Troubleshooting and Introduction to the Principles of Digital Communication. Further details may be obtained from the company.

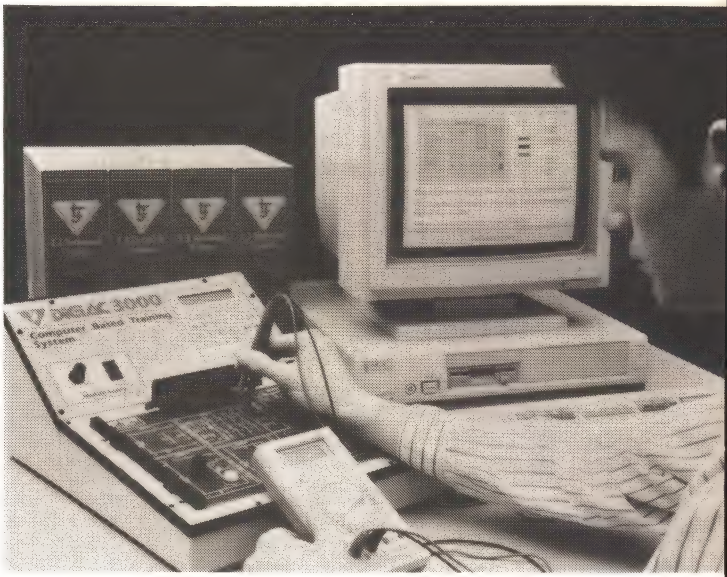
Boxing clever

Mention ***Boxford*** and most people immediately think of *lathes.* During the last 40 years, this British company has manufactured more than 50,000 units the vast majority of which are still providing reliable service all over the world. Boxford also produce a wide range of machine tools for general workshop use and for education and training purposes.

However, Boxford are mentioned here because of their bench top PC controlled machine tools. The CNC milling and turning machine tools have been produced specifically for education and training purposes yet are capable of cutting steel to close tolerances.



Boxford's 160 computer controlled lathe.



The Digiac 3000 computer based training system for Electronics from LJ Technical Systems.

CNC features include a full-colour graphic representation and editing facilities whilst programming. It is possible for the profile of the workpiece to be drawn on the display screen with the software producing the program in standard format.

The suppliers

Looking through the pages of *EPE* you will see that many of our advertisers specialise in mail order supplies, offer catalogues (mostly free) and many also issue regular "special bargain" discount listings. We strongly recommend readers obtain as many catalogues/listings as possible as considerable savings can be made on follow-up orders. Incidentally, most orders are processed on a "next day" service, provided, of course, shelf stocks allow.

To highlight the efficiency and growth of todays electronics components supplier we have picked on just two examples of the developments that have taken place over the last few years. We have taken the "two sides of the coin" approach to show how one company (Maplin) *started* from the *amateur market* to progress to become a powerful force in the commercial or trade supply area and the other side, where, finally recognising the tremendous potential and growth of the amateur marketplace, one of Europe's largest *trade only* distributors RS Components set up their own mail order company (Electromail) to make their products readily available to the amateur.

Years ago, if you wanted an electronic component, you visited the local radio shop. In those days the range of materials was small and the shop would, as likely as not, have what you were looking for. Times have changed. The sheer range of modern components has meant that the local shop cannot hold a complete stock of items many of which would not sell for months or years.

To many people, the answer is *mail order.* Mail order companies generally publish a catalogue and ordering is made direct. Sometimes ordering is made in response to an advert in a magazine. The larger suppliers have vast stocks and draw from a warehouse. Computer control of stock and despatch makes the whole operation very quick and efficient. Electronic component suppliers generally sell peripheral devices such as general electrical materials, tools, etc. too.

Sometimes catalogues are provided *free* either on request or as a supplement provided from time to time in a magazine such as *EPE.* Those from some of the major suppliers are very thick and have to be paid for – about £2 to £3 is the going rate (Some of these contain redeemable vouchers which offer discounts against goods ordered which soon makes up for the price of the catalogue). These still represent good value and can be a source of ideas and data and as a means of checking prices.

Now that credit cards are so widely used, most companies will accept a telephoned order paid for by credit card and this saves time. Most will guarantee despatch within one or two days and some will guarantee despatch on the same day if the order is placed early enough. For urgently needed items, special services are available at extra cost. However, for the amateur, the standard post is usually sufficient.

Most suppliers impose a carriage charge and sometimes a minimum order value – perhaps up to £10. The conditions vary widely and need to be checked carefully. Some companies carry a restricted range and only stock the more popular items. Their overheads are less so they usually supply what they do have more cheaply. Beware though – it may seem tempting to order your needs from several cheaper suppliers but you may end up paying more because of the multiple carriage charges.

Another thing to look out for is whether VAT is included in the price. Many companies quote prices without tax and this makes their product lines appear cheaper than they really are. Remember to add this on to compare like with like.

Radiospares

Electromail is a division of RS Components UK – possibly the largest industrial distributor in Europe. The RS group have companies in Australia, Austria, Denmark, France, Germany, Italy and the Republic or Ireland. Since its inception in 1937, RS has grown to become a major force in the sale of all technical products.

Originally RS Components was called *Radiospares* and so entrenched is this name that many old hands still refuse to give the name up! In the early days, Radiospares did indeed stock spare parts for the repair of radios, record players and televisions – there was little more to electronics in those days.

The Autumn 1937 Radiospares Price list boasted "A replacement for Every Job and a 24 hours' service on top of it!" Listed was a selection of *condensers* (now called capacitors), resistors, volume controls, pilot bulbs, gramophone motors, pick-ups, output transformers and fuses. There was also a range of valves costing from about 3/6d each (about 18p).

Unfortunately for the amateur, until recently the resources of RS were unavailable because the company only serves approved account holders such as industrial concerns, schools and colleges. For many years, there was a wish by amateurs to have access to the vast range of components in the RS catalogue – actually this is now three substantial volumes. At the time of writing these list some 38,000 product lines and are still growing.

This is why Electromail was formed in July, 1986 as the cash-with-order outlet for RS components. This makes all components listed by RS available to the amateur and commercial user who only requires occasional access to the RS range.

The similarities between Electromail and RS Components are: (1) both companies share the same product lines; (2) they both use the same stock numbers and (3) they both have the same prices. The differences between the companies are: (1) with Electromail anyone can order; (2) with Electromail payment must be made by cheque, credit card etc in advance; (3) Electromail guarantee next day despatch whereas RS guarantees same day despatch.

Electromail customers can buy the catalogues for £6.50 (there are special offers from time to time) whereas RS customers are sent a new set three times per year free. Electromail charge a flat rate of £2.95 for carriage and there is no minimum order value whereas RS customers pay no carriage charges. Electromail customers do not receive sales back-up as do RS customers and, finally, Electromail do not export – this is done only by RS.

Customers of Electromail may request the extremely useful RS Data Sheets which are available for many components listed in the catalogues. These provide detailed information, suggested circuits, etc. and are invaluable to the would-be designer and experimenter. Up to five individual sheets may be requested free of charge when an order is placed or by sending a self-addressed A4 envelope with two First Class stamps.

The three-volume components catalogue set from Electromail costs £6.50.

Strong growth

A very efficient company that has grown rapidly over the years is ***Maplin Electronic Supplies.*** Over the financial year ending June, 1993, Maplin achieved a 27 per cent sales increase which was a rise of 45 per cent on the previous year. The company are very proud of this increase despite the recession.

The stock range is now such that both the amateur and professional can obtain most of their needs. In 1990 the Maplin Distribution Centre opened near Barnsley. Here, 10,000 orders per week are despatched to 500,000 customers world-wide. Orders are placed at the Rayleigh, Essex base and are transferred by computer link to the distribution centre.

They publish a full-colour catalogue which may be obtained from any branch of W. H. Smith at £2.95 or direct from the company. As well as illustrating and pricing each product – some 9000 lines from 500 suppliers – it provides much background information and will be found invaluable for reference. Vouchers are also given in the catalogue – £50 worth in the 1994 catalogue – which enable discounts to be obtained on goods valued at £10 or more. Full details for overseas ordering are given in several languages.

Phone lines

Ordering may be made by telephone using a credit card but Maplin have introduced an interesting variant of this – the *Key Call* system. By using a tone-dial telephone (or a separate handheld tone dialler) an order may be placed at any time and on any day of the week. This can save costs by using the off-peak telephone period.

To make an order, the code for each item required is written down from the catalogue. Suppose the order code is FF15R (this is the Maplin code for a radial 470µF 16V electrolytic capacitor). The final letter is ignored and the letters in the code translated into numbers using the table provided at the back of the catalogue. The letter F translates to 16 so the complete Key Call code is 16 16 15. This is then dialled in.

However, before using this service, you will need a PIN (personal identification number) and a customer number if you do not have one already. These numbers may be obtained by telephone. Once "into" the system, voice messages guide the user through the procedure of ordering and, at the end, the credit card number and expiry date are similarly entered. First-timers are advised to practice a few times without actually ordering.

The Maplin component Distribution Centre warehouse at Wombwell, Barnsley.

For some years, customers with a computer and modem have been able to access the Maplin mainframe computer using the *Cashtel* system. The user is guided through the procedure of placing an order, checking previous orders, etc. Availability of the required item can be checked and an order placed by quoting a credit card number. Maplin promise that all orders placed by whatever means and received before 5p.m. will be despatched the same day.

They also operate a chain of retail outlets in the major regional areas – 27 at the time of writing. Most are catalogue shops but a few are self-service stores. By visiting one of these, you have the advantage of being able to handle and discuss the product with the staff. Also, you will save on carriage charges. The shops stock most items but, obviously, it is impossible for them to carry the complete product range and the more obscure items will need to be ordered.

Maplin's target sales increase is 100 per cent over the next four years. This, they hope, will come about from the contribution of new shop sites, greater sales in the industrial market and increased effort in Europe and the Middle East.

That's all for this month we hope the information has been informative and useful. Remember, there are many more excellent British companies than those discussed here – so keep looking! ☐

ADDRESSES

National College of Technology, Ltd. PO Box 11, High Street, Wendover, Buckinghamshire. HP22 6XA. Tel: 0296 624270/613067

Economatics Education Ltd. Epic House, Darnall Road, Attercliffe, Sheffield, S9 5AA. Tel: 0742 561122

Flight Electronics Ltd. Flight House, Ascupart Street, Southampton, Hampshire, SO1 1LU. Tel: 0703 227721

LJ Technical Systems Ltd. Francis Way, Bowthorpe Industrial Estate, Norwich, NR5 9JA. Tel: 0603 748001

Boxford Ltd. Wheatley, Halifax, West Yorkshire, HX3 5AF Tel: 0422 358311

Electromail. PO Box 33, Corby, Northants, NN17 9EL. Tel: 0536 204555

Maplin Electronics PLC. Mail Order: PO Box 3, Rayleigh, Essex, SS6 8LR. Tel (sales): 0702 554161 Tel (enquiries): 0702 552911

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National College of Technology, NCT Ltd., PO Box 11
Wendover, Bucks. Tel: (0296) 624270

Constructional Project

WATERING WIZARD

T. R. de VAUX-BALBIRNIE

On-demand garden care while you're away from home. Automatic watering from a few seconds to 2½ hours. Daily – Every Three Days – Weekly.

KEEPING the garden watered can be a problem especially when you are away on holiday. This automatic watering system will turn on a hosepipe or lawn sprinkler at regular preset times – daily, every three days or weekly.

Water can be delivered for any pre-selected time from 15 seconds to 2½ hours approximately. The time of day when watering takes place may also be chosen anywhere in the 24 hour cycle according to the user's preference.

This unit differs from simpler systems in working *on demand*. That is, water being delivered only when the soil is dry enough to need it. A control on the front panel is adjusted to the dampness threshold and a red l.e.d. indicator lights continuously when the soil exceeds this.

Note that it is not possible to provide *precise* soil dampness control. The intention is simply to inhibit the system when it has been raining or possibly when sufficient water has reached the sensor from the hosepipe itself.

DAILY TIMINGS

A further control on the front panel sets the hose "on" time and a green l.e.d. glows while it is actually operating. A four-position rotary switch selects the time between operations – one day, three days or one week – these being referred to as "daily timings" in the text. The fourth position provides a manual on-off function.

The Watering Wizard is mains-operated and designed to be stood on a shelf in a **dry indoor location** – perhaps in the garage. There must be a power socket available – the unit is not designed to be permanently connected to the mains.

The water supply is best provided by an *outside* tap. This ensures that, in the event of the hosepipe becoming detached or a leak or burst occurring, the flow of water will not cause a catastrophe. A tap having a standard threaded outlet is advised.

The device which actually controls the water is a *solenoid valve* (see Components List). The inlet of this is attached to the water tap which is then left turned on. The hosepipe is attached to the outlet. When the solenoid valve is energized by current flowing through its coil, a diaphragm moves and allows a through-flow of water.

In use, the solenoid valve coil is connected to the main unit using a small plug and socket. A "moisture sensor" is inserted into a representative patch of soil and this is connected to a further socket. Since these external circuits operate at low voltage, any light-duty twin wire may be used.

The prototype unit was tested up to a distance of 20m (more than 60ft) from the soil probe and was found to work well. The solenoid valve may be situated any reasonable distance from the main unit.

LOCAL REGULATIONS

Before constructing the watering system, readers are advised to check the relevant regulations with their local water company. In particular, it may be necessary to pay a fee as for a conventional lawn sprinkler.

While away on holiday, it will be necessary to have a neighbour available to switch the unit off if a hosepipe restriction comes into force.

HOW IT WORKS

The Watering Wizard is illustrated in block diagram form in Fig. 1. The basis of daily timings is a quartz-controlled clock movement which provides an output signal each hour. Pulses may also be injected manually using a push-button switch (Input Pulses) for setting-up purposes. The pulses are de-bounced using a 0·2 second monostable, counted using a 12-bit counter and applied to a system of logic gates whose outputs are switched to provide outputs at the chosen daily timings.

The appropriate output triggers a precision timer which provides the actual hose *on* time – this time is adjustable using the Set Time control. Providing the soil probe detects dry conditions, the output from this triggers a further (two-minute) monostable. However, if the soil is wet, the water sensing section disables it – the Threshold

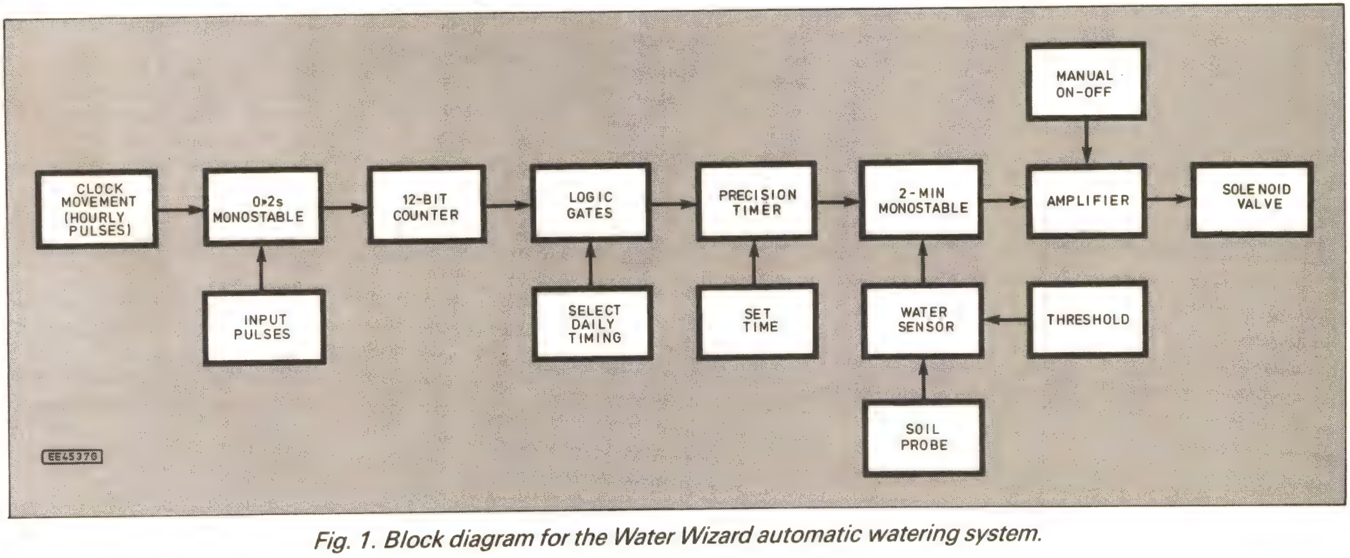
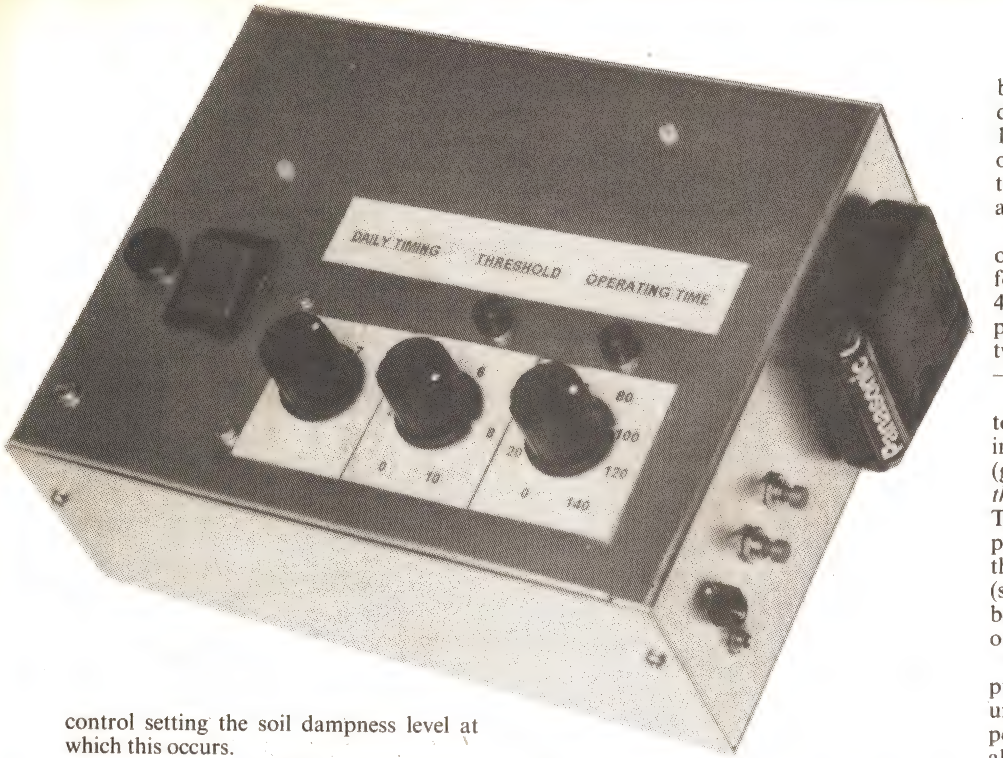


Fig. 1. Block diagram for the Water Wizard automatic watering system.



control setting the soil dampness level at which this occurs.

The output from the two-minute monostable is amplified and operates the solenoid valve. The Manual *on-off* switch triggers the solenoid valve independently of the rest of the system so may be used to operate the hosepipe at any time.

The specified quartz clock movement is very inexpensive but highly accurate – to within seconds per month. This is the cheapest way of providing the daily timings combined with the required accuracy.

Accuracy is thought to be important since otherwise the hose operating time would tend to drift as the days passed. Over a two or three-week holiday the time difference could be considerable and the hosepipe would not then operate at the chosen time of day.

There is no need to fit hands to the clock and in the prototype unit the movement was mounted *back-to-front* on the side of the case (see photograph). This allows easy access to the single AA cell powering it.

CIRCUIT DESCRIPTION

The complete circuit diagram for the Watering Wizard is shown in Fig. 2. Power is derived from a conventional arrangement of mains transformer, T1, twin rectifier diodes, D1 and D2 and smoothing capacitor, C1. A fuse, FS1, and double-pole on-off switch, S1, with neon indicator are included in the primary circuit.

The mains transformer must be a high-quality component and be adequately rated (see Components List). This will ensure that it remains cool during continuous operation and maintains isolation of the mains from the low-voltage section in the event of a catastrophic failure.

The clock contacts already exist as part of the movement. The true purpose of these is to trigger a separate chip and loudspeaker to provide "chimes" on the hour. However, in the present application this part is not used and only access to the switch contacts is required. The connection to these is provided by a pair of wires which pass out through the case. The movement must obviously be of the type having this internal switch (see *Shoptalk*).

The clock contacts, in common with other mechanical switches, tend to bounce when they "make". A typical switch will bounce several times before the contacts settle down to make proper contact. If the switch was used to provide signals to the counter *direct*, multiple pulses would be registered on each bounce and the result would be unpredictable.

To overcome this problem, IC1a and associated components form a "de-bouncing" circuit. IC1a is one half of a dual timer i.c. – that is, two identical timers in one package – each connected as a *monostable*.

When the clock contacts "make" on the first bounce, IC1a trigger input, pin 6, becomes *low* momentarily so initiating a timing period. The output, pin 5, then goes *high* for a time dependent on the values of fixed resistor R2 and capacitor C3, then reverts to *low*. With the component values specified this will take 0·2 seconds approximately. This time is not particularly critical so no adjustment is provided.

While the output is high, the monostable is insensitive to further trigger pulses so contact bouncing has no effect. All bouncing will be over within the 0·2 second time period so the monostable will provide only one output signal each hour.

Resistor R1 keeps IC1a trigger input normally high and this prevents false operation. Pushbutton switch S2 (Input Pulses), connected in parallel with the clock contacts, provides "false" pulses and this will be found useful for setting-up and testing purposes later.

Light emitting diode D3 (Confirm Pulses), provides a flash with each triggering of the monostable. Again, this will be found useful at the setting-up stage. Capacitors C2 and C9 are necessary for internal stability of IC1.

COUNT YOUR BLESSINGS

The output pulses from IC1 pin 5 are applied to the clock input (pin 10) of the 12-bit counter IC2. These are counted with the outputs going high to represent the number registered. Not all outputs are used – only those shown in Fig. 2 – that is, the "eights", "sixteens", "thirty-twos", "sixty-fours" and "one hundred and twenty-eights". The corresponding pin numbers for these are 5, 3, 2, 4 and 13 respectively.

For a *daily* output signal, 24 pulses will be needed, while for an output each three days, 72 are required and for once a week, 168. Since 24 is 16 + 8, it follows that an output each day will be provided when the "eights" and "sixteens" outputs (pins 5 and 3) are high simultaneously.

Similarly, 72 is 64 + 8 so a three-day output may be obtained when the "sixty-fours" and "eights" are high (pins 5 and 4) together. For weekly timings, three outputs need to be high – "one hundred and twenty-eights", "thirty-twos" and "eights" – that is, pins 13, 2 and 5 respectively.

These output combinations are applied to the inputs of the three separate triple-input NAND gates contained within IC3 (gates a, b and c being responsible for *daily, three-day* and *weekly* timings respectively). Table 1 shows the truth table for a 3-input NAND gate and it will be seen that all three inputs (A, B and C) need to be *high* (supply positive voltage) for the output to be low – that is, *off*. In all other cases the output is *high*.

For one-day timing, only *two* IC3a inputs (pins 2 and 8) are needed so the unused one (pin 1) is connected to the positive supply line – that is, it is made *high* already. Similarly, for three-day timing, two IC3b inputs are used (pins 11 and 12) and the unused one, pin 13, made high. For weekly timing, all three IC3c inputs are needed (pins 3, 4 and 5) and it is to accommodate this last case that triple-input gates are used rather than the more usual 2-input variety.

Table 1: 3-Input NAND gate truth table

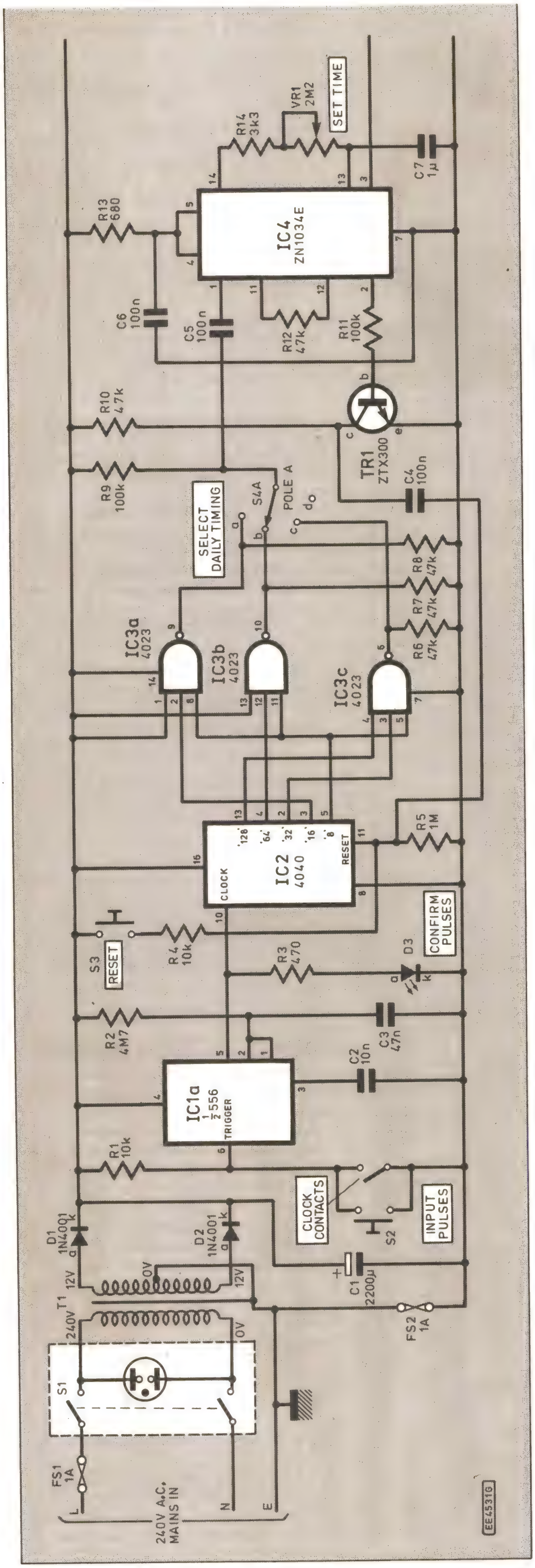
A	B	C	OUTPUT
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

PRECISION TIMER

The outputs from IC3 gates (pins 9, 10 and 6) are connected to the fixed contacts of the Daily Timing switch S4a (a 3-pole 4-way rotary switch). Although this switch has three poles, only *two* of them, A and B, are used in this circuit. Pole B provides the manual *on* function and this will be explained later.

Pole A moving contact (wiper) is used to select IC3 output appropriate to the timing required – position *a* for daily operation; position *b* for once each three days and position *c* for once every week. When the appropriate gate output goes low this state is transferred momentarily, via capacitor C5, to IC4 trigger input pin 1. IC4 is a precision timer configured as a long-period monostable. This has twin outputs and, on the arrival of a low pulse, one of them – pin 3 – goes from low to high and the other, pin 2, from high to *low*.

The low state of IC4 pin 2 is transferred to the base of transistor TR1. The transistor therefore turns *off* and the collector is made *high* via resistor R10. This state is transferred momentarily, via capacitor C4, to IC2 reset input, pin 11. Thus, having counted the required number of pulses, IC2 is reset to begin a further cycle.



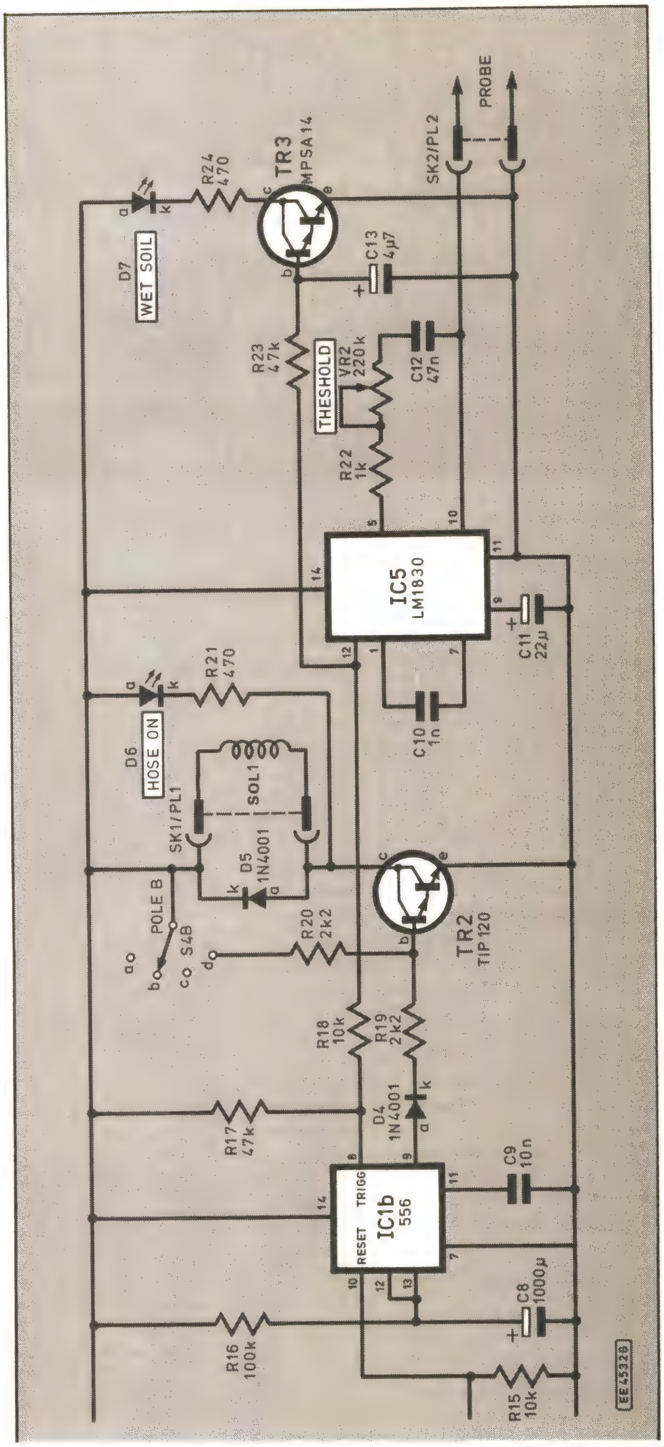
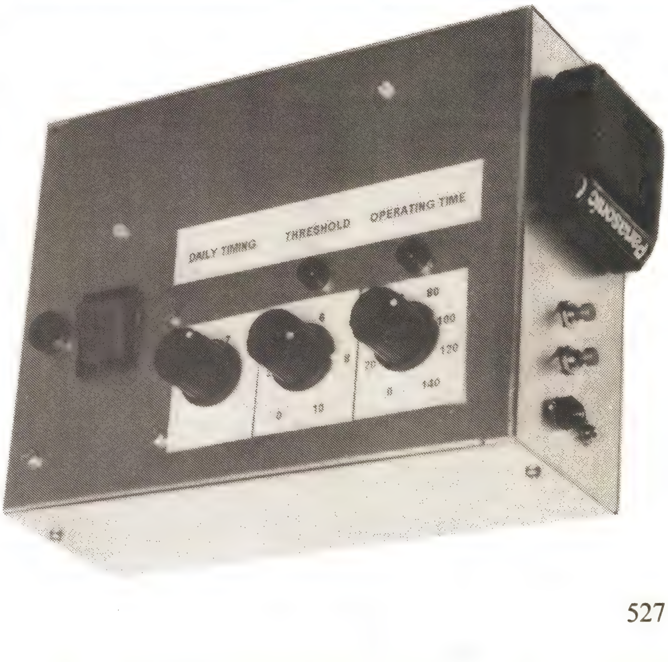


Fig. 2. Full circuit diagram for the Watering Wizard.



Resistor R5 keeps the reset input normally low which prevents false operation. IC2 may also be reset manually using switch S3 which applies a high state to pin 11 through resistor R4. This will be useful at the setting-up stage.

Meanwhile, the high state of IC4 pin 3 maintains a high state on IC1b reset input, pin 10, which lasts until the end of the timing cycle. IC1b is configured as a monostable and keeping pin 10 high in this way enables the chip. Thus, when a *low* state is applied to its trigger input, pin 8, the device will switch on with IC1b output pin 9 going high for a certain time then reverting to low.

The trigger input signal is derived from the water-sensing section in the manner to be described presently. The time period of the monostable will depend on the values of fixed resistor R16 and capacitor C8 and, with those specified, will be two minutes approximately.

At the end of IC4 timing period, pin 3 goes low so IC1b reset input also becomes low. This disables the chip, the output (pin 9) goes low, and the trigger input (pin 8) has no effect whatever on its logic state.

WET, WET, WET.

The moisture-sensing section is based on IC5 and associated components. This i.c. is described as a Fluid Detector and is really designed to sense the "straight" presence or absence of a conducting liquid such as would be needed for a water level switch. However, it can also be used to sense the presence of moisture in absorbent substances such as soil and provide an on-off action.

Changes in the amount of water cause changes in resistance between the contacts of a sensor probe pushed into the material being monitored. When current flows through this "resistor", a certain voltage is developed across it – as predicted by Ohm's Law, the higher the resistance the higher the voltage will be. It is this voltage which controls the action of IC5.

The advantage of this particular i.c. is that it uses *a.c.* (alternating current) at the probes rather than d.c. (direct current) and this helps to overcome problems of chemical degradation of the probe material. The probe therefore remains in good condition for long periods and will probably only need to be checked and cleaned occasionally.

An on-chip oscillator provides the a.c. at a frequency determined by the value of capacitor C10, connected between pins 1 and 7. The actual frequency is not critical and with the value stated will be 6kHz approximately.

Since water conducts electricity and especially since there are various conducting substances present in it, damp soil will result in a relatively low resistance being developed at the probe. This is compared with that of a reference resistor.

In the original application, this is built into the i.c. However, for the present purpose the operating point needs to be adjustable so that the system will take account of the type of probe used and the amount of conducting substances dissolved in the water. In practice this means that the on-chip resistor is unsuitable. Instead, potentiometer VR2 (Threshold), connected as a variable resistor, together with fixed resistor R22, connected externally to pin 5 is used. This is coupled to pin 10 through capacitor C12.

The output pin 12 of IC5, is connected to the collector of an on-chip transistor. When the resistance between the probe contacts is higher than the reference value (dry soil) a signal is coupled to its base – when the probe resistance is less than the reference value, the signal is removed.

The output signal is normally a.c. and, as such, would be unsuitable. Capacitor C11 is therefore included and this behaves as a smoothing capacitor or *filter* allowing a steady d.c. output to be provided at pin 12. Thus, when dry soil is detected, the collector of the on-chip transistor, pin 12, goes *low* and makes IC1b trigger input, pin 8, low via resistor R18. This triggers IC1b providing it is enabled with pin 10 (reset input) high as described previously.

DAMPNESS CHECK

When IC4 begins its timing cycle, the dampness of the soil is therefore checked and, if dry, IC1b pin 9 will go high. Current then flows via diode D4 and current-limiting resistor R19 to the base of Darlington transistor TR2. This, in turn, directs current through the solenoid valve coil, SOL1, in its collector circuit. At the same time, green light-emitting diode D6 (*Hose On*), glows.

Diode D5 by-passes the reverse high-voltage pulse which occurs when the

COMPONENTS

See SHOP TALK Page

Resistors

R1, R4, R15, R18	10k (4 off)
R2	4M7
R3, R21, R24	470 (3 off)
R5	1M
R6, R7, R8, R10, R12, R17, R23	47k (7 off)
R9, R11, R16	100k (3 off)
R13	680
R14	3k3
R19, R20	2k2 (2 off)
R22	1k

Possible additional resistor for probe – see text.
All 0.25W 5% carbon.

Potentiometers

VR1	2M2 standard rotary carbon, linear
VR2	220k standard rotary carbon, linear

Capacitors

C1	2200µ radial elect. 25V
C2, C9	10n ceramic (2 off)
C3, C12	47n disc ceramic (2 off)
C4, C5, C6	100n disc ceramic (3 off)
C7	1µ metallised polyester film, 100V
C8	1000µ radial elect. 25V
C10	1n ceramic
C11	22µ radial elect. 25V
C13	4µ7 radial elect. 25V

Semiconductors

D1, D2, D4, D5	1N4001 1A 50V rect. diode (4 off)
D3	3mm red l.e.d.
D6	5mm green l.e.d. indicator
D7	5mm red l.e.d. indicator
TR1	ZTX300 *npn* silicon transistor
TR2	TIP120 *npn* Darlington power transistor
TR3	MPSA14 *npn* Darlington transistor
IC1	NE556 dual bipolar timer
IC2	4040BE 12-bit counter
IC3	4023BE triple 3-input NAND gate
IC4	ZN1034E precision timer
IC5	LM1830 fluid detector

Miscellaneous

SOL1	Solenoid valve with 12V d.c. 57ohm coil and ½in. BSP threaded ports. See *Shoptalk*
S1	Double-pole rocker switch with integral neon indicator contacts rated at 240V 1A minimum.
S2, S3	Miniature push-to-make switch (2 off)
S4	3-pole 4-way rotary switch, break-before-make action.
T1	Miniature mains transformer 6VA rating minimum. Mains 240V a.c. primary; 12V-0-12V secondary (or twin 12V secondaries)
SK1/PL1	2·1mm power type plug and socket (plastic type with both connections insulated from the metalwork.)
SK2/PL2	3·5mm mono jack plug and socket.
FS1	20mm panel fuseholder fitted with 1A ceramic mains-type fuse.
FS2	20mm chassis fuseholder fitted with 1A glass fuse.

Printed circuit board available from *EPE PCB Service,* code 883; 14-pin d.i.l. i.c. holder (4 off); 16-pin d.i.l. i.c. holder; control knob for VR1, VR2 and S4 (3 off); aluminium box, size 203 x 152 x 76mm; solder tags (2 off); rubber grommet; small fixings; 0·25in. mono jack plug for probe (see text); strain relief bush; stand-off insulators; solder; 3A 3-core mains wire; light-duty twin wire, etc.

Chiming clock movement – see *Shoptalk.*

Approx cost guidance only **£38** *plus case* magnetic field in the solenoid valve core collapses when it switches off. Without this, semiconductor devices in the circuit could be damaged.

So long as the soil is dry enough, IC1b trigger input, pin 8, will remain low so the i.c. is constantly triggered and pin 9 will provide a continuous *high* output. It will then remain in this state until IC4 times out.

However, if the soil becomes wetter than the dampness threshold, the low trigger state will be removed. The hose will then remain on for IC1b time period i.e. two minutes. If the soil then becomes dry again, it will be re-triggered and the hose will switch on again. This may happen any number of times during the main (IC4) time period.

The purpose of the monostable based on IC1b is to ensure that, once triggered, the hose will switch on for two minutes minimum. This ensures that the solenoid valve cannot switch repeatedly at the critical soil dampness level which would be a nuisance.

While the soil is damp and IC5 pin 12 high, current flows via resistor R23 to the base of Darlington transistor TR3 and turns it on. This then illuminates the red "Wet Soil" l.e.d, D7. This will be useful to refer to at any time.

The fourth position of switch S4 (position d) provides the manual on/off function, It operates by allowing current to flow directly from the supply via S4b and fixed contact *d* through resistor R20 and hence to the base of transistor TR2. The solenoid valve in the collector circuit then operates. This over-rides all other functions so the hose can be used whenever needed.

In its present form, potentiometer VR1 adjusts the hose operating time from 15 seconds to 2½ hours approximately. Many readers will need a maximum operating time much less than this. It would then be possible to reduce the value of capacitor C7 in proportion. For example, 0·22µF will provide a maximum timing of 30 minutes approximately.

CONSTRUCTION

Since constructing this project involves making mains connections, readers who are unsure of being able to make a safe job must seek the advice of a qualified electrician. In particular, the circuit must be built in an Earthed aluminium box and both mains and low-voltage sections correctly fused as indicated. Mains on-off switch, S1, should be of the double-pole type having an integral neon indicator. Before removing the lid of the case for any reason, the unit must be switched off and unplugged from the mains.

Most of the components for the Watering Wizard are mounted on a single-sided printed circuit board (p.c.b.). A full-size copper foil pattern and topside component layout are shown in Fig. 4. This board is available from the *EPE PCB Service*, code 883.

Begin construction by drilling the four mounting holes, 2mm in diameter in the positions shown. The recommended component assembly order is as follows: First, the five i.c. sockets and the link wire then diodes D1, D2, D4, D5 and on-board l.e.d. D3 taking care over the polarity of each.

Follow this with all fixed resistors and capacitors. Take particular care over the polarity of C8, C11 and C13 since these are electrolytic capacitors and will be damaged if connected the wrong way round.

Next, add the transistors noting that TR2 is generously rated and needs no heatsink. Do not insert the i.c's into their sockets yet.

Connect 20cm pieces of light-duty stranded connecting wire to the circuit board positions marked S2, S3, S4, D6, SK1, SK2, D7, VR1, VR2 and T1 secondary. Use of different coloured wires – for example rainbow ribbon cable – is recommended since this will reduce the chance of making an error which could be difficult to find later.

Make a careful check of the completed circuit board then prepare the case for it. Note that everything is secured to the

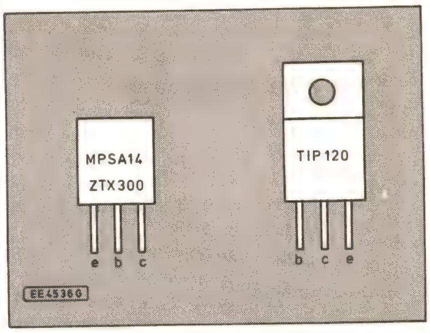


Fig. 3. Pin identification for TR1 and TR3 looking at the flat on their bodies and for TR2, viewed from the front.

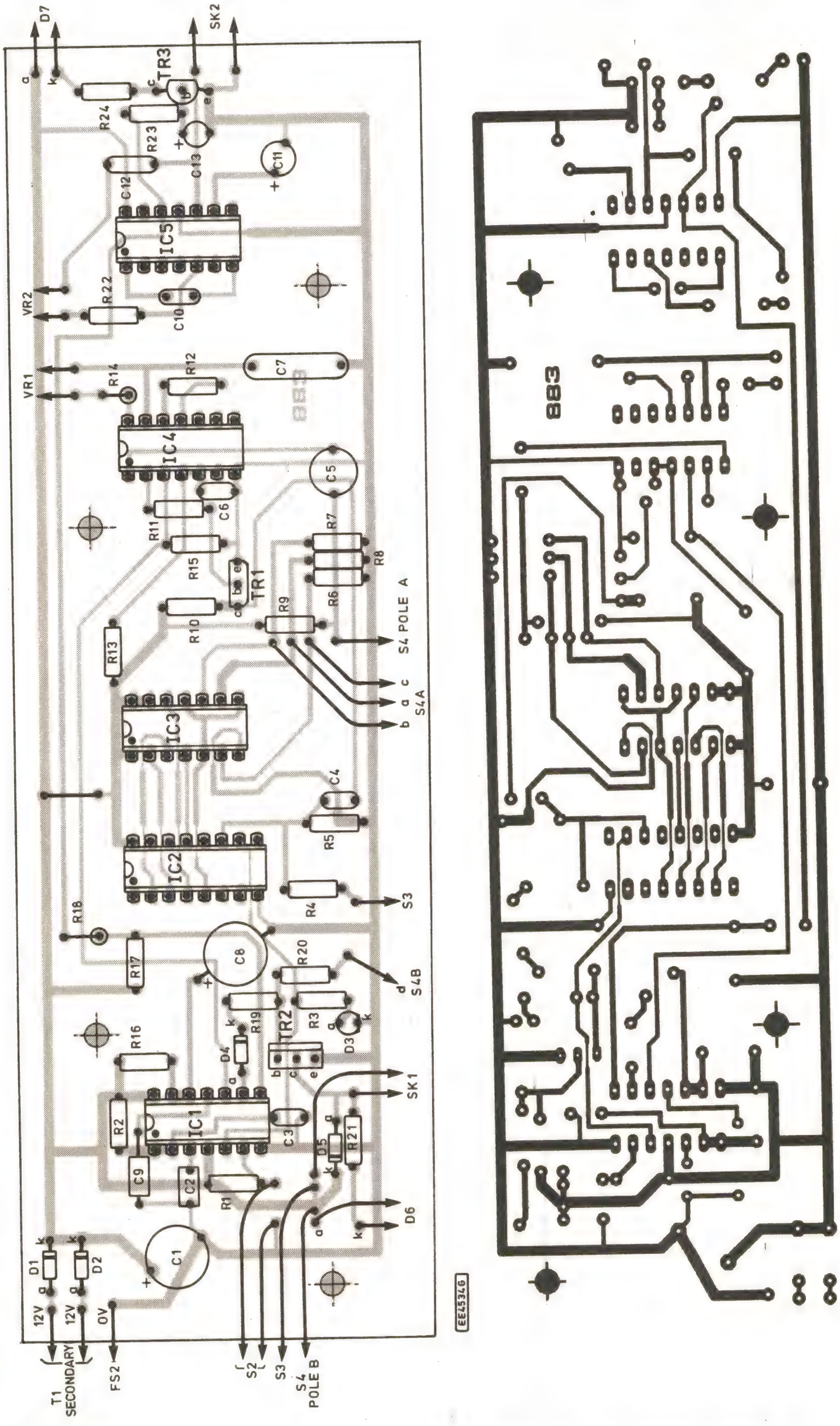


Fig. 4. Printed circuit board component layout and full size underside copper foil master pattern.

base section of the box – in view of the large number of inter-connecting wires, this method provides least strain.

THAT'S THE DRILL!

With the circuit board held in position, mark the base of the box through the mounting holes. Remove the board again and drill holes to correspond. Drill holes for rotary switch S4, Set Time and Threshold potentiometers VR1 and VR2, switch S1 and for fuseholder FS1.

Follow with the holes for transformer mounting, for switches S1 and S3 and for fuseholder FS2. Drill holes for the l.e.d. indicators D6 and D7 and for solenoid valve and probe sockets SK1 and SK2 – note that these sockets are of different types so that the probe and solenoid valve cannot be connected in the wrong sense.

Although the 3·5mm mono jack socket used for the probe (SK2) may have one of its terminals connected to the metal box, the power-type socket (SK1) used for the solenoid valve **must be of the *fully isolated type*** – that is, with neither terminal connected to the metalwork. Check this point before ordering.

Drill a hole for the strain relief bush to be used on the mains input wire and a further one for the rubber grommet which will be used to protect the clock movement wires where they pass into the case. Drill the hole in the side for mounting the clock movement (see photograph).

Measure the position of l.e.d. D3 on the circuit panel and drill a hole in the top section of the box directly above it. This is so that it may be seen with the case assembled.

Cut down the spindles of VR1, VR2 and S4 to a length suitable for the control knobs. This is best done by gripping the spindle in a small vice and, while supporting the body by hand, cutting the spindle using a small hacksaw. Gripping the *body* of the device in the vice is likely to damage it.

INTERWIRING

Mount the completed p.c.b. on 5mm long stand-off insulators so that all soldered connections remain clear of the box. Use a piece of stiff thick cardboard on the base to provide additional insulation if necessary.

Mount all remaining components except the clock movement since this part is easily damaged. Note the solder tags at T1 fixings. Refer to Fig. 5 and complete the internal connections shortening any wires as necessary.

To make the diagram clear, some of the wiring is cut short and lettered instead of being carried through between components. Simply connect together wires having the same letter. The polarity of the transformer secondary wires marked *A* is unimportant.

Using cable ties or spiral wire-wrap to collect wires into groups will help to make a tidy job. Note that the connections to potentiometers VR1 and VR2 outer tags should be made as shown in Fig. 5 (rear view) or the adjustments will work in the opposite sense.

If the 3·5mm jack socket (SK2) used for the probe connection has one terminal making metallic contact with the case, then this must be the one connected to the negative supply track on the p.c.b. as shown. If this procedure is not observed the probe connections will be effectively short-circuited and the circuit will interpret this as *wet soil*. This will then inhibit operation of the system.

MAINS WIRING

Take particular care over the mains wiring (shown in bold print in Fig. 5). This must be carried out using ***mains-type wire of 3A rating minimum.*** The input lead must be secured using a strain relief bush through the hole drilled in the case for the purpose. The Earth wire must be soldered securely to the solder tag at T1. ***This earths the case and is essential for safety reasons.***

Insulate switch S1 connections using heat-shrinkable sleeving. Insulate FS1 tags using an insulating boot or further heat-shrinkable sleeving. Make certain that no mains wires – including the earth wire to the solder tag – can pull free from internal components in service.

Insert a 1A mains-type *ceramic* fuse in fuseholder FS1 and a 1A glass one in FS2. Fit the mains plug and insert a 2A or 3A fuse. Attach the control knobs.

Finally, fit the clock movement to the side of the case. Use the rubber washer supplied between the case and the plastic body – this will help to grip the movement and prevent it from rotating. Fit a rubber grommet in the hole drilled for the clock contact wires to pass into the case.

Insert the i.c's into their sockets taking care to observe the orientation. IC1 is a bipolar device and needs no particular handling precautions. However, the other i.c's are of the CMOS variety and so

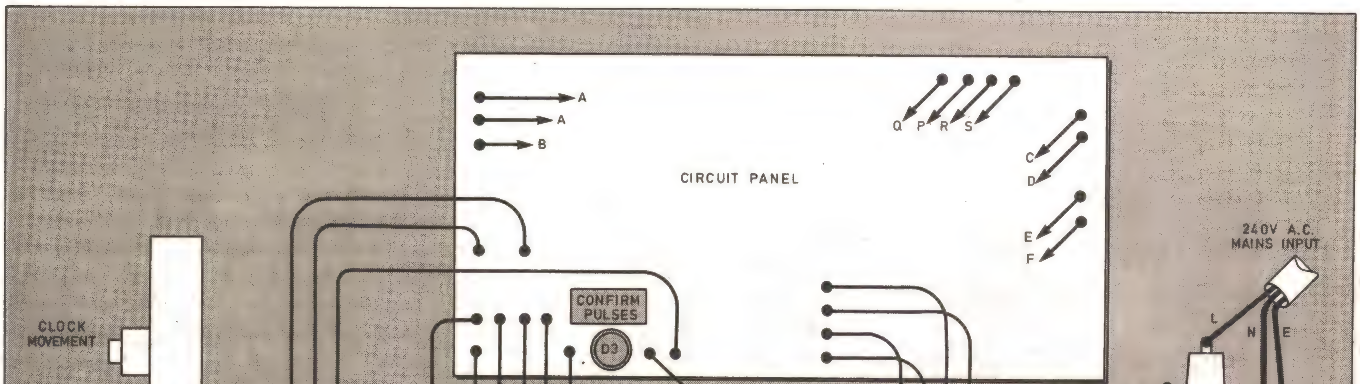


Fig. 5. Interwiring from the circuit board to all off-board components.

vulnerable to damage by static charge which might exist on the body.

To be safe, either avoid touching the pins while inserting the i.c's or touch something which is earthed (such as a water tap) before handling them. Assemble the two sections of the case checking carefully to avoid trapped wires and any possible short circuits.

TESTING

A basic test may be made without the soil probe, clock contacts or solenoid valve being connected. Stand the case on a shelf with the transformer at the bottom – the unit will then be stable. The green (Hose On) l.e.d. will signal when the solenoid valve would be on if it were connected.

Solder a short piece of twin wire to the 3.5mm jack plug. Remove the insulation from the other end but do not let the wires touch for the moment. Plug this into SK2 (Probe Input).

Set VR1 and VR2 to minimum adjustment and S4 for one-day timing (all knobs fully anti-clockwise).

Plug the unit into the mains and switch on. The neon indicator should light up. Since the probe wires have effectively an infinite resistance between their ends, the circuit will interpret this as "dry soil" and the red l.e.d. D7 should remain off.

Press Reset switch S3 to make sure that the counter is at zero. Now press S2 (Input Pulses) briefly but deliberately observing l.e.d. D3 through the hole in the case. This should give a flash with each operation. Press it 24 times to represent one day of hourly clock signals. The green l.e.d. D6 (Hose On) should now light for two minutes approximately, that is IC1b time period.

If the circuit works so far, set switch S4 to "three days" (next position clockwise). Press S3 to reset the counter and operate push switch S2 72 times. Again, D6 should light. Check on the "weekly" setting in the same way pressing S2 168 times. It is important not to become over-enthusiastic and press S2 too quickly – check that the on-board l.e.d. goes off with each operation.

Test the Manual on-off function by rotating switch S4 to its most clockwise position. If everything works correctly, rotate VR1 spindle about one-third of its total clockwise travel and check that the operating time is in the region of 50 minutes.

With the timing control VR1 at its minimum setting again, twist the sensor wires together. Since there is now effectively zero resistance between them, the circuit will interpret this as "wet soil" and the red l.e.d. indicator (Damp Soil) should come on.

Set S4 for "one day" again and press S2 24 times. Operation should now be inhibited and the green l.e.d., D6, should fail to light. If the circuit performs correctly in all these tests, it is likely to work as it should with the soil probe connected.

SOIL PROBE

The probe used in the prototype unit was a standard (0·25in) mono jack plug pushed into the soil up to the shoulder. It is thought that the slightly more expensive gold-plated type would be better but an ordinary nickel-plated one was used in the prototype unit. The damp soil provides the "resistor" which bridges the tip and sleeve connection of the plug.

Some readers will wish to experiment with different types of probe. One idea is to use separate wires of various lengths and with different spacing. Trials may be made using a bucket of soil which may be dampened to simulate correct conditions.

The probe must make proper contact with the soil. Best results were obtained in the prototype by using a small quantity of compost placed in a hole in the soil then "planting" the probe into this firmly.

Insert the probe in fairly dry soil or compost. Connect it to the unit using a piece of light-duty twin wire terminating in the 3·5mm jack plug. Switch on the mains. With the Threshold control VR2 fully anti-clockwise the red l.e.d. should be off. If it is already on, it will be necessary to increase the probe resistance.

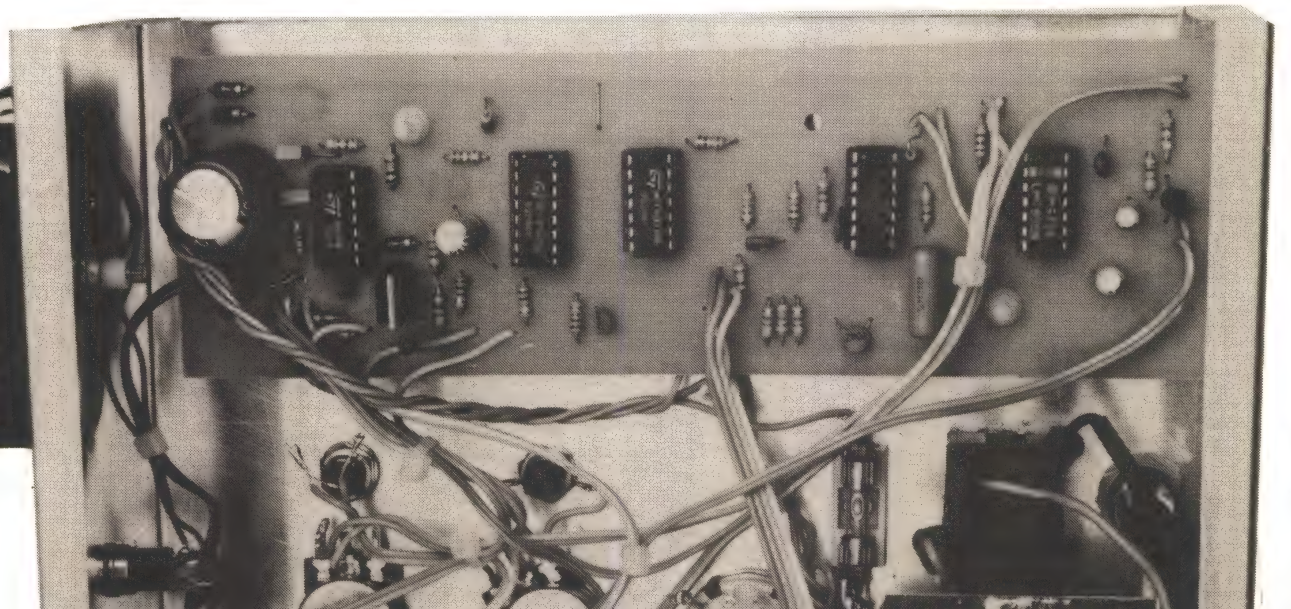
With experimental probes the length of the wires may be reduced or the spacing increased. However, with a jack plug probe, it will be necessary to connect a fixed resistor in series with it. This may be done by removing the wire from the non-earthed terminal of SK2 (the one connected to IC5 pin 10). A fixed resistor is then connected in the gap. Experiment with the value – 47 kilohm or 100 kilohm is a good starting point.

Rotate VR1 slowly clockwise – at a certain position, the red l.e.d. indicator should switch on. With VR2 adjusted back to the point where the red l.e.d. is *just* off, dampen the soil further and note that it comes on again.

Check operation of the solenoid valve. It does not need to be actually attached to the water tap yet. Connect its terminals to a piece of light-duty twin stranded wire and solder the power-type plug to the other end. Plug this into SK1 on the unit. Trigger the circuit as before. This time, the solenoid valve will be heard to click as it operates.

OPERATING TIME

Pass the wires from the clock movement though the grommet and into the case. Solder them to switch S2 terminals along with the existing wires – polarity unimpor-



Layout of components inside the metal case. The clock movement, mounted "back-to- front", can be seen top left.

tant. Fit the battery to the clock movement – listen carefully to check that it ticks each second.

It is now necessary to adjust it so that pulses are given on the hour. To do this, wait for the hour then turn the small knob on the rear of the movement (which would normally be used to adjust the hands) until l.e.d. D3 *just* flashes. A pulse will now be given on each subsequent hour.

This does not provide an exact setting. If this is thought to be important, small steps of adjustment will need to be made under actual working conditions.

The simplest way to set the Hose On time is to wait for the desired operating time to pass (i.e. for the clock contacts to click) then press Reset button S3. An alternative method is to insert the required number of "missing" clock pulses using push switch S2 (Input Pulses).

To do this, begin by pressing S3 (Reset) to make sure that hourly counting begins at zero. Suppose water is to be delivered each day at 6p.m. and the present time is 10.30a.m. Press S2 *16 times* to represent the pulses which would have been provided by the clock since 6p.m. the day before – that is, the first one for 7p.m, the second for 8p.m. and so on. The seventeenth one will be given automatically at 11a.m. and so on with the twenty-fourth at 6p.m. as required. Observe the on-board l.e.d. as you do this – if you make a mistake, press the Reset button and start again.

SLUGGISH OPERATION

Attach the solenoid valve to the water tap. The specified unit is fitted with BSP threaded male ports. A plumbers' merchant or DIY store will supply the fittings needed to attach it to the tap and hose. Note that the ports look the same but there is a definite input and output – with the specified valve, an arrow inscribed on the plastic body identifies the direction of flow.

If the run of wire between the solenoid valve and main unit is very long, it may be necessary to use thicker wire to avoid an excessive voltage drop. This will be clear if the solenoid valve operates sluggishly over a long distance but correctly over a short one.

Check operation. Note that the solenoid valve may trigger while the red l.e.d. is still on under marginal dampness conditions. This is because there is a slight overlap in the operating characteristics. Some readers will wish to allow some of the hosepipe water to reach the probe – it really depends on the operating characteristics required. There may be some repeated operation at two minute intervals when the soil dampness is close to the threshold level – this is of no consequence.

To cut the hose operating time short at any time, turn VR1 control knob to minimum – the solenoid valve will switch off after 15 seconds approximately. It is suggested that long operating times should not be used until the soil probe has been tested to satisfaction. Note that if the probe is changed or moved, the threshold level as set by VR2 will change.

The controls should now be labelled. Scales should be made for S4, VR1 and VR2 – this latter (Threshold) one will probably be a simple arbitrary scale marked 0 to 10 (see photograph). For VR1 it will be sufficient to find the maximum time then mark off the scale in equal steps.

It may be necessary to build a small housing around the water tap to protect the solenoid valve connections from the effects of the weather. It may also be necessary to waterproof the top part of the probe – possibly by coating it with epoxy resin adhesive. This will prevent water entering and possibly altering the operating point.

INDEPENDENT MEANS

A letter received from a reader recently wished to know if a circuit such as this could operate a mains pump to remove water from a well or other private water supply. There is no reason why this could not be done. Instead of the output feeding a solenoid valve, it would supply current to a relay coil instead. The normally-open ("make") contacts would then switch current from the mains to operate the pump.

The relay used would need to have a 12V coil and *mains-rated* contacts. Since the pump motor will draw a much greater current when it starts than when it is actually running, it will be necessary to use a relay with heavy-duty contacts and it is suggested that these should have a current rating of 16A minimum.

A larger box than that specified should be used with the relay mounted inside on a small subsidiary circuit panel. ***Note that since mains connections are involved, all safety procedures must be followed and the help of a qualified electrician sought in any case of doubt.***

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Home Base

Jottings of an electronics hobbyist – Terry Pinnell

Lofty Ambitions

As I write this I am in the final stages of preparing to move from my home of many years. So my "home base" is in a state of extreme chaos right now.

The problem is not just all those mundane matters that even electronics enthusiasts have to turn their attention to now and again, like defrosting the freezer, buying new curtains, arranging for gas, electricity and phone accounts to be transferred, and so on. No, the major challenge is the task of re-establishing my electronics, which is beginning to look very daunting.

One issue is simply the difficulty of unpacking the huge quantity of stuff I have amassed over the years. Test gear, wire, components – and projects of every type. My new house is smaller and has few existing shelves, so an immediate job must be to install some. But that means first unpacking tools, workmate, wood, brackets, screws, drill, etc – which will be difficult until I can make enough space by getting the gear off the floors. Onto shelves? A sort of vicious circle really.

A solution I might have adopted would have been to peek into each box and then hoist a lot of non-essential items up to the loft to give me elbow room below, especially in the two small rooms I've ear-marked as office and workshop respectively. But I packed with insufficient thought, mixing disparate things that should have been kept apart. Magazines and coils of wire; circuit boards and spare light bulbs; writing materials and mains plugs.

Even if I had done a better planning job, the loft idea has other serious shortcomings. Not only does my new one have no boards, lights or loft-ladder (three luxuries that I knew I'd probably have to forego for a while) but it is also very low, with lots of struts hindering movement and storage.

I normally like keeping my car in the garage, especially in the cold months to escape the chore of ice-scraping and those teeth-chattering minutes before the heater gets underway. But maybe I'll have to relegate it to the elements and use the garage as a store-cum-workshop for a while.

Breaking up is very hard to do

That's still a few days away though. Meanwhile I'm dealing with practical problems at this end, such as dismantling the astonishing proliferation of projects and interconnecting wiring throughout the house.

That's not especially time-consuming in itself, mind you. In fact it's remarkable (and a bit depressing) just how quickly a project that took weeks or months to design, build and install can be "terminated" with screwdriver and wire-cutters. My domestic burglar alarm for example was soon sitting inertly in a cardboard box awaiting transport to its new home.

Or rather the control unit was. Its input and output wiring connecting to doors, windows and siren, some of it taking tortuous routes up into the loft and back down again, is still mainly intact, tucked into carpets or skirting boards.

I guess it's unlikely that the new owners will benefit from it much though. Even equipped with an inherited wiring diagram, would most alarm specialists be interested in taking advantage of previous installations? I doubt if it would be worth the trouble.

Anyway, I think the modern approach to home security systems has moved away from microswitches and reed relays and now uses infra-red proximity detectors. It's quite likely that my own alarm unit will never be called into active service again, as I fancy the new type too. I expect installation is much easier and neater as there is so little wiring involved, and a few detectors can protect a wide area.

I don't know how reliable they are though. Unlike those simple interrupted-beam types, presumably these heat-detecting systems can't be triggered by the occasional moth? Even a very hot moth that's just spent five minutes orbiting your 100 watt hall light? But pets must be tricky, apart from cold-blooded types like lizards and alligators.

What do you do about kitty and her cat-flap, or leaving the dog in while you nip up to the shops? Maybe the detectors can be angled so that objects near the floor are outside their range? That wouldn't be satisfactory though, surely? Apart from inviting would-be burglars to crawl around your living room, it still wouldn't allow for your cat jumping onto the kitchen table.

Getting back to dismantling, haste can cause its own problems too. I decisively cut through a few dozen wires running into a hole through a wall, sure the wires were now redundant. After all, the new owners would hardly share my strange need for wind speed and direction reporting in the bedroom. But in amongst that lot were three other wires, which would have left the newcomers waiting a long time for their first call on the telephone extension!

Take it or leave it?

As you may have gathered if you've been reading this column for a while, my house is strewn with a a variety of gadgets of varying degrees of usefulness. And, like beauty, that's probably a quality that depends on the eye of the beholder.

What I might personally regard as useful could well arouse as much interest in my successor occupant as an ice-lolly offered to an eskimo. Deciding which projects to leave in place was not clearcut. One project that I considered leaving intact, but eventually decided to dismantle in the vague hope of using it again, was my Garage Parking Aid.

I designed this when I was temporarily relegated to the shorter side of our double garage. My car would just fit into its modest length with about one inch to spare, and the up-and-over door could then be closed.

Because it was the right hand side (as you face the garage), backing-in was necessary, as otherwise I couldn't get out of the car. This manoeuvre was actually quite tricky, as there were a number of fixtures and fittings on the rear wall that wouldn't stand too much bumper-bashing, like the gas pipe running up to the meter.

So what was needed was a clear signal that the car had reached the correct position. I therefore mounted a couple of sturdy pieces of timber vertically up the wall, and fitted a microswitch with normally-open contacts to each of them.

By trial and error I improvised the actuators of these with pieces of springy wire so that one switch would close when the car's bumper was about two inches from hitting the timber, and the other would close when the distance was about half an inch. If the bumber went back hard onto the timber, it would still clear the gas pipe and other things permanently on the wall.

An amber lamp would come on when the car touched the first switch and then a red one as it reached the correct position for parking. The lamps were small 15W pygmy types, mounted on a U-shaped piece of aluminium which was positioned so that I could see them easily as I reversed into place (which obviously ruled out l.e.d.s – they had to be visible in the bright daytlight too).

Mains

Needless to say, you don't want mains voltages on such exposed switches, or the associated long runs of mains wiring, so a d.c. circuit was required to drive the lamps. I used two identical lamp driver circuits, using a triac and simple home-made pulse transformer in each, for complete isolation.

In fact, the drivers were very similar to the one I described in my very first *Home Base* article, for powering my Loft Light. Anyway, safety apart, another requirement was that the lights should not stay on indefinitely, so a monostable timer was also incorporated; it is triggered as soon as the "amber switch" is closed and provides d.c. power to the triac drivers for about five minutes. I suppose I could have dispensed with microswitches and electronics completely, instead covering the timber with some rubber or something, and just backed up the car gently.

I guess that would have achieved the same end in a simpler fashion, although arguably not so elegantly. And I certainly wouldn't have had the fun of designing and building it.

My present car is even smaller, so the Parking Aid has been redundant for a year now. And unless my new garage is a lot shorter than it has a right to be, I'm not sure when the device will next be called upon to do its stuff. Come to think, maybe I need a bigger car?

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POCKET PRINT TIMER

ANDREW CHADWICK

A neat and inexpensive photographic timer providing sound outputs over a wide range of time periods including one and two second bleeps.

A FEW years ago the author decided to take a serious interest in photography, enrolled on a part-time course in order to learn a bit more about the subject. As well as teaching the basic techniques of photography, the course introduced the fascinating, and sometimes frustrating, art of printing black and white photographs.

After a few sessions in the darkroom, it soon became apparent how important it was to have a methodical and reliable technique in order to produce quality prints. However, progress was being hampered by silly mistakes with timing, and the unit described in this article was designed to improve matters.

Producing a black and white print is not a particularly difficult procedure. The exposed paper is immersed in turn in three chemical solutions known as "developer", "stop-bath" and "fixer". The time spent in each is determined according to the manufacturers recommendations, and depends on the particular brand of chemicals, their concentration and the type of paper being used.

These times are usually measured by using a stop-clock, or the seconds hand on a conventional watch, but both methods have disadvantages. A stop-clock has to be stopped, reset and started each time. A normal watch is difficult to see in the dim safelight, and it is all too easy to forget when the time period started. Neither method gives an audible warning at the end of the time period.

The Print Timer overcomes these problems by allowing the development time and the fixing time to be set independently. Each time is controlled by a single pushbutton switch which resets and starts the timing. At the end of the set period the unit bleeps briefly.

The two times can be set in the range from 30s to 7·5 minutes in 30s steps, which is adequate for most chemicals. A d.i.l. switch is used to program the times as they are unlikely to be changed frequently.

Whilst developing the circuit it was realised that another useful function could be provided at little extra cost. One of the advantages of black and white printing is the ability to control the final image by burning and dodging. These techniques involve giving a few seconds more or less exposure to the print when it is under the enlarger, by shielding the light with the hands or a piece of card.

The difficulty is judging the time accurately and consistently. The Print Timer solves this problem, as it can be switched to emit audible bleeps at one second or two second intervals.

Although the circuit was designed with photography in mind the timer could also have other applications such as games where there is a time limit for each contestant.

DESIGN

The main criteria when considering the design of this circuit were cheapness and simplicity. Another requirement was that it should be possible to house the circuit in a particular type of compact case with battery compartment and belt clip that has recently come on the market.

These criteria were the main reasons for using a d.i.l. switch to set the times. Also, it was felt that a simple *RC* timing circuit would be sufficiently accurate and would be cheaper than a crystal controlled timebase. CMOS logic was chosen for its low power consumption and wide operating voltage.

It had been hoped to dispense with an on-off switch by utilising the very low static current consumption of CMOS logic but this proved impossible. However a spare position on the switch meant that it is possible to have two levels of volume, useful if you are working in a communal darkroom and don't want to disturb others!

Some commercial devices were examined but they didn't provide the facilities wanted, although they could be set very accurately and had an LCD display.

CIRCUIT DESCRIPTION

The full circuit diagram for the Print Timer is shown in Fig. 1. The timer function is based on IC2, a 4-bit programmable divide by N counter. The clock signal to pin 4 of this i.c. is produced by the *RC* oscillator and 14-stage divider, IC1, and has a period of 30s.

When one of the timer buttons S4 or S5 is pressed a 4-bit binary number set on the d.i.l. switch S3 is presented at IC2's preset inputs A to D. At the same time a pulse generated by capacitor C1 and resistor R2 is applied to the preset enable (PE) pin of IC2 so that the number is loaded into the counter. The same pulse resets IC1 and via IC3a enables the astable multivibrator formed by IC3d and IC3c thus producing a short bleep from the piezo transducer WD1.

Counter IC2 now begins counting down, and when the count reaches zero, pin 12 goes "high". This triggers the simple *RC* monostable, formed by resistor R7, capacitor C2 and IC3a, which enables the astable and produces a longer bleep. The signal from pin 12 is also inverted by IC3b and applied to pin 6 to inhibit further counting.

Diodes D3 to D10 select the appropriate four switches of the 8-way d.i.l. switch S3 when switch S4 or S5 is pressed. If a switch is on, a high level or binary 1 will be

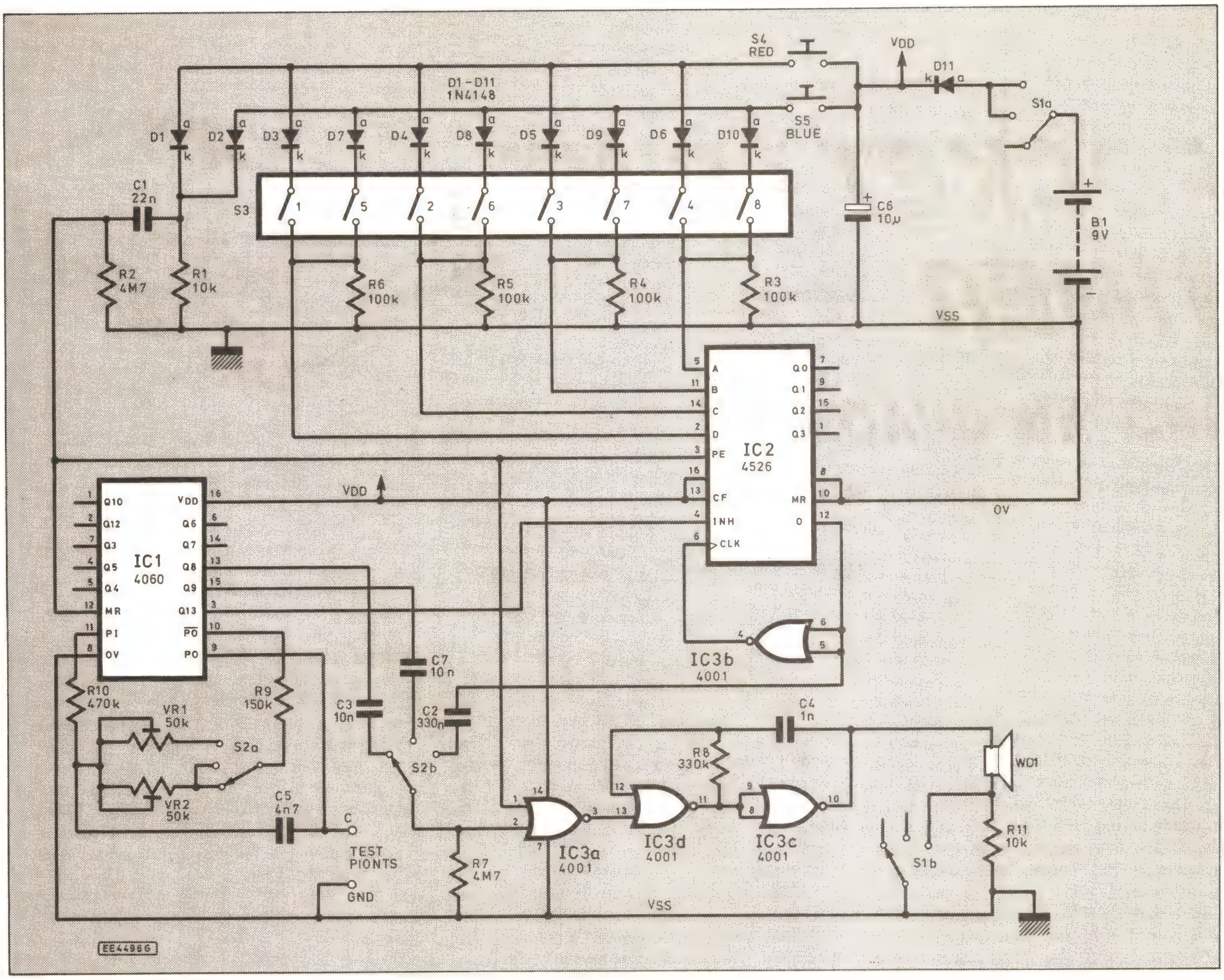


Fig. 1. Complete circuit diagram of the Print Timer.

produced at the preset input of the counter. If a switch is off then the result will be a low level or binary 0 due to pulldown resistors R3 to R6. The timer period will therefore be the 4-bit binary number represented on the switches multiplied by the 30s clock period.

SECONDS OUT

In the seconds mode S2a selects VR2 which changes the oscillator frequency slightly so that the square waves at IC1 pins 13 and 15 have periods of 1s and 2s respectively. Switch S2b connects one of these outputs to IC3a via an *RC* differentiator formed from either capacitor C3 or C7, and resistor R7.

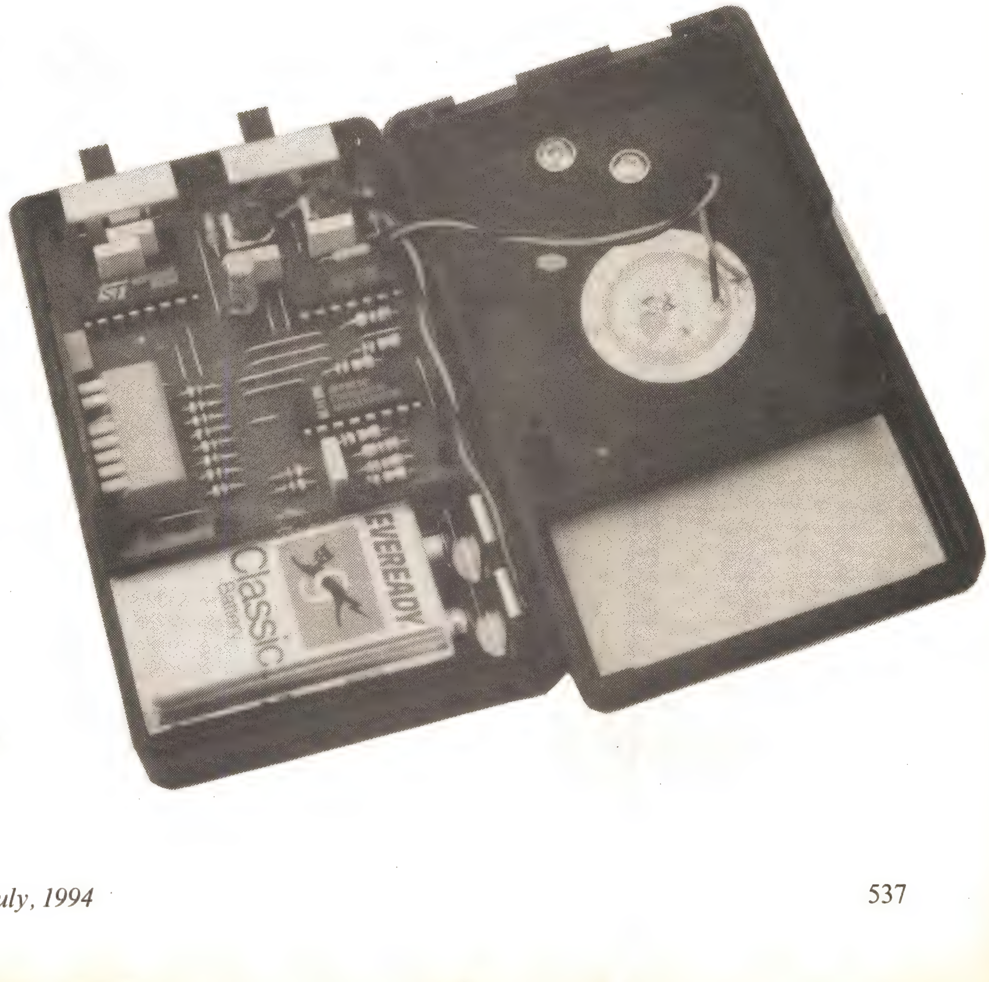
Each rising edge of the square wave therefore causes a brief pulse at IC3a output pin 3, which enables the astable, and produces a blip (a very short bleep!) in the transducer WD1.

Diode D11 protects against reverse power supply polarity. Resistor R11 reduces the audio volume when not shorted out by S1b.

CONSTRUCTION

The printed circuit board (p.c.b.) copper foil master design and topside component overlay are shown in Fig 2. The p.c.b. has been designed to fit in the specified case and is fairly densely populated.

Some component sizes are critical and should be as specified in the components list – see *Shoptalk* page. If purchasing



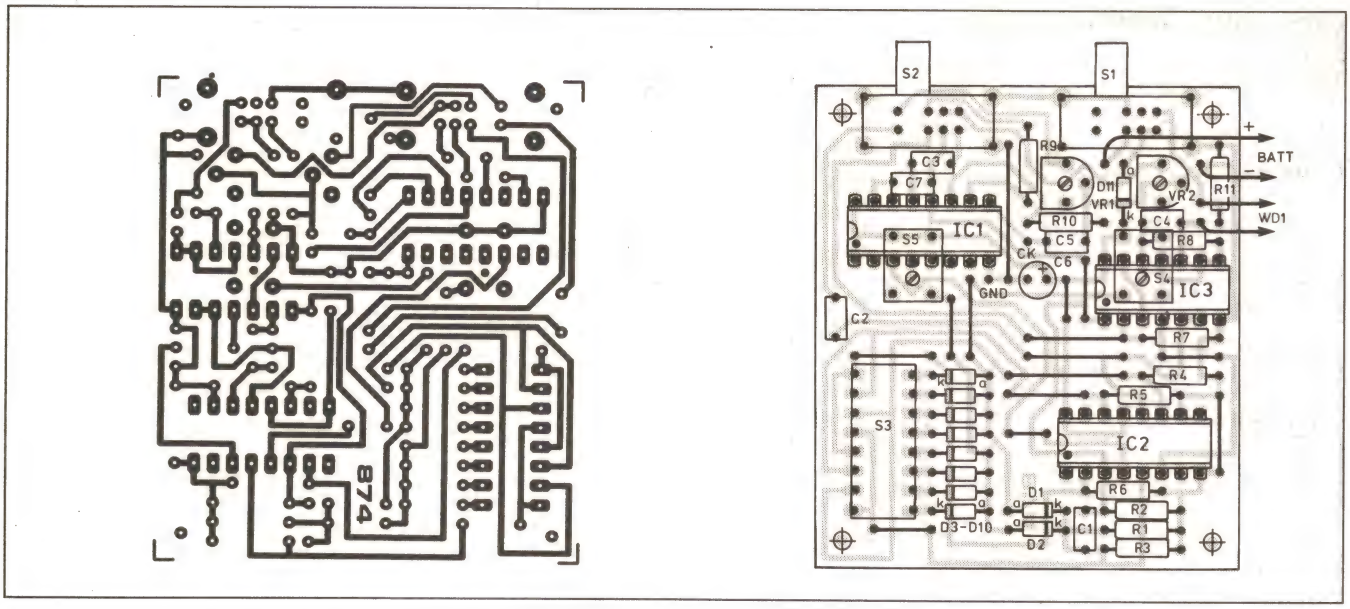


Fig. 2. P.C.B. layout and wiring for the Print Timer.

elsewhere check component dimensions and lead spacings carefully and make sure they will fit on the board, before ordering.

For those who undertake to make their own p.c.b., a 0·8mm drill should be used for all component pads apart from those for VR1, VR2, S4 and S5 which should be 1mm. The mounting holes for S1 and S2 should be 1·3mm diameter. Don't worry if the bottom lefthand pad of S1 is removed completely when drilling, as this leg is not meant to be soldered to the board.

Drill four 3/32 inch diameter holes as shown at the corners of the board. These should correspond to the pegs in the case if the board has been produced accurately. Before mounting any components check the fit of the board in the case and file the edges slightly if necessary.

Switches S4 and S5 are mounted *on the copper side* of the board. In order to ensure that the cutouts in the front of the case correspond with the switches, first position the p.c.b. in the case, and, using the switch mounting holes in the p.c.b. as a guide, drill through the front of the case. Remove the p.c.b., mount the switches on the front of the case in the holes just drilled, and carefully mark the outline of the switches on the case. Don't make the cutouts yet.

Returning now to the circuit board, insert and solder all components in position. Start with the lowest profile components but leave the i.c.s and switches S4 and S5 to the end.

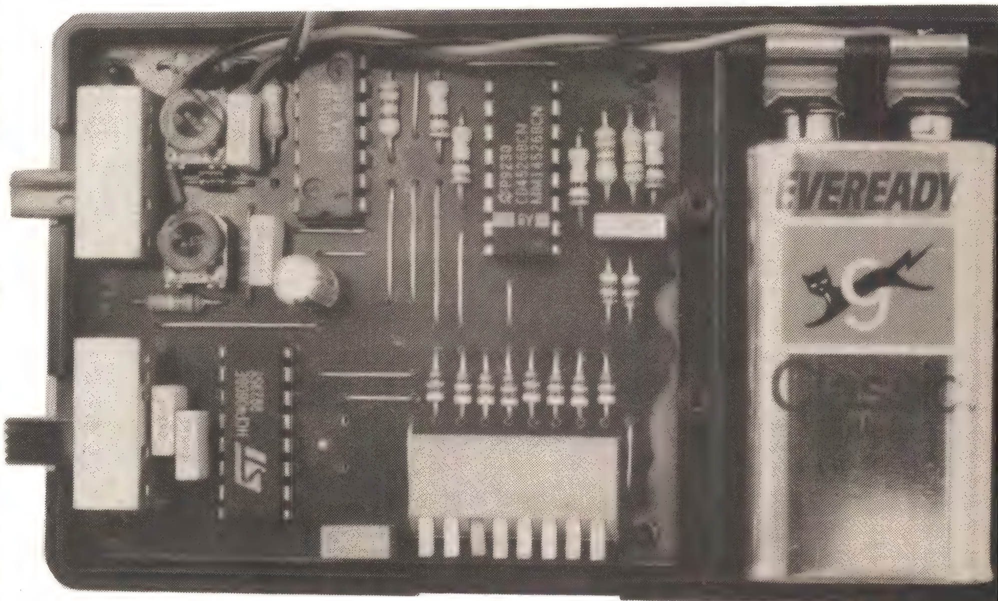
STATIC

The i.c.s must be inserted and soldered whilst observing static handling precautions. If you do not wish to solder the i.c.s directly onto the board, then low-profile i.c. sockets can be used.

Switches S4 and S5 can now be fitted to the copper side of the board. Use the minimum of solder on the other component leads that lie near or under the switches and trim the leads close to the board.

Trim the legs of the switches so that they will not protrude through the board and ensure they fit flush to the board before soldering. It may be necessary to remove two of the standoffs on the switches so that they don't foul other component leads.

Solder two short lengths of wire in the pads marked CK and GND so that they protrude about a quarter of an inch. These will be used as test pins when setting up.



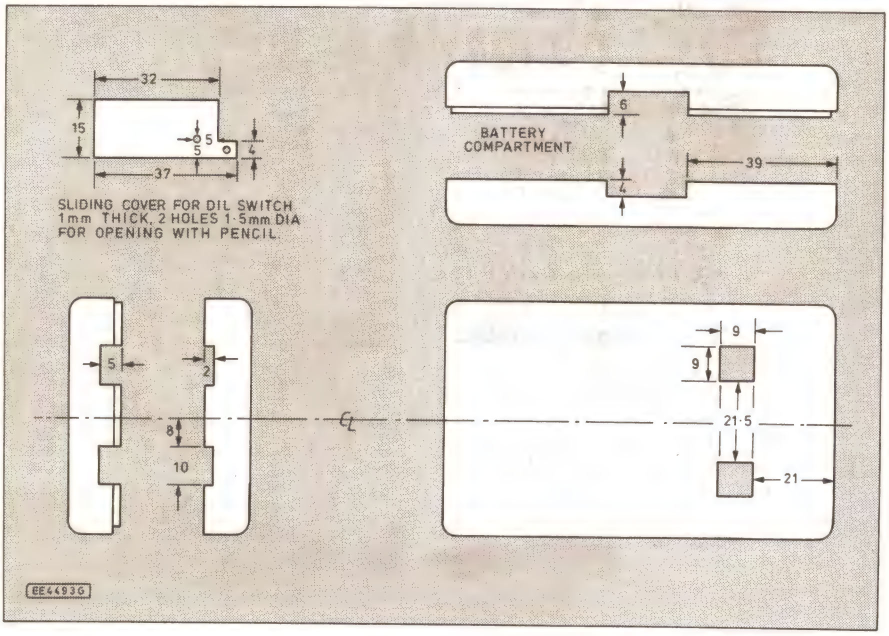


Fig. 3. Case cutting and blanking panel details.

COMPONENTS

See SHOP TALK Page

Resistors

R1, R11	10k (2 off)
R2, R7	4M7 (2 off)
R3, R4, R5, R6	100k (4 off)
R8	330k
R9	150k
R10	470k

All 0·25W 5% carbon film

Potentiometers

VR1, VR2	50k cermet preset, lin.

Capacitors

C1	22n	5mm lead pitch polyester
C2	330n	
C3, C7	10n (2 off)	
C4	1n	
C5	4n7	
C6	10µ radial elect. 16V	

Semiconductors

D1 to D11	1N4148 signal diode (11 off)
IC1	4060 14-stage counter
IC2	4526 4-bit programmable divide by N counter
IC3	4001 quad 2-input NOR gate

Miscellaneous

S1, S2	2-pole 3-way slide switch (right-angle – 2 off)
S3	8-way d.i.l., s.p.s.t. piano-style switch
S4	p.c.b. mounting s.p.n.o. momentary action press switch, red
S5	p.c.b. mounting s.p.n.o. momentary action press switch, blue
WD1	Piezo-electric transducer element (27mm 1·8kHz)

Printed circuit board available from the *EPE PCB Service*, code 874; plastic handlheld case, with pocket clip; 9V battery (type PP3); multistrand connecting wire; solder etc.

Approx cost guidance only **£15**

CASE DETAILS

It is easier to make the case cutouts before completing the wiring. Fig. 3 shows the rough dimensions but for a neat finish start off with smaller holes than these and gradually enlarge them, frequently checking for a good fit by positioning the board on its pegs. This particularly applies to S4 and S5. Finally drill out the marked holes and fit the belt clip if this is required.

Wiring to the p.c.b. is very simple as can be seen from Fig 2. Solder wires to the battery terminals before fitting them to the battery compartment. Use the minimum of heat if leads need to be soldered to the piezo transducer WD1. Stick it to the pocket clip side of the case with double-sided tape.

If desired, cut out a sliding cover for the d.i.l. switch from a piece of scrap black plastic as shown in Fig 3. To avoid confusion it is best to label the slide switches and the d.i.l. switch.

The labels were designed using the graphics facility on a p.c.b. design program and then printed twice full size on a dot-matrix printer as shown in Fig 4. The printout was photocopied, reducing it by 50 per cent, and the labels cut out and sandwiched between slighter larger pieces of double-sided tape and clear sticky-backed plastic. This sandwich was trimmed to the dimensions of the label, the backing paper removed from the tape and stuck in position.

TESTING AND SETTING UP

Make a final inspection of the board checking for solder bridges before connecting the power. If you have a variable voltage supply gradually increase the voltage whilst monitoring the current; this should be around 0·3mA.

If all is well select one second and two second bleeps in turn with switch S2 and check that the volume of the bleeps can be changed by moving S1. The volume on the lower setting can be altered by changing the value of resistor R8.

Select the Timer mode with S2 and set the d.i.l. switch S3 to give 30s on one timer and one minute on the other. When either pushbutton is pressed there should be a short bleep followed by a longer bleep at the end of the time period.

If you have a frequency counter connect it between the CK and GND test points. Select the timer mode with S2 and adjust VR1 to give an indication of 546·1Hz. Select either of the bleep modes and adjust preset VR2 to give 512Hz. If you don't have access to a frequency counter then use the seconds hand on a watch and a bit of patience!

USE

The method of setting the required time on the d.i.l. switch S3 should be clear from the label shown in Fig 4. Fig 5 shows one timer set to 30s and the other to 1·5 minutes. ☐

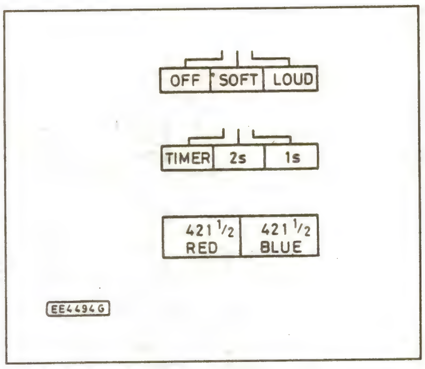


Fig. 4. Label designs.

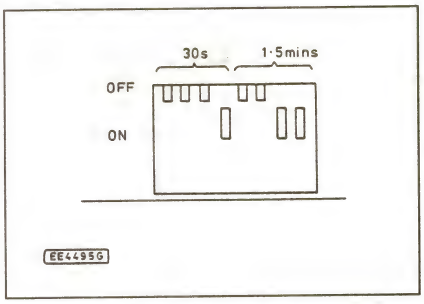
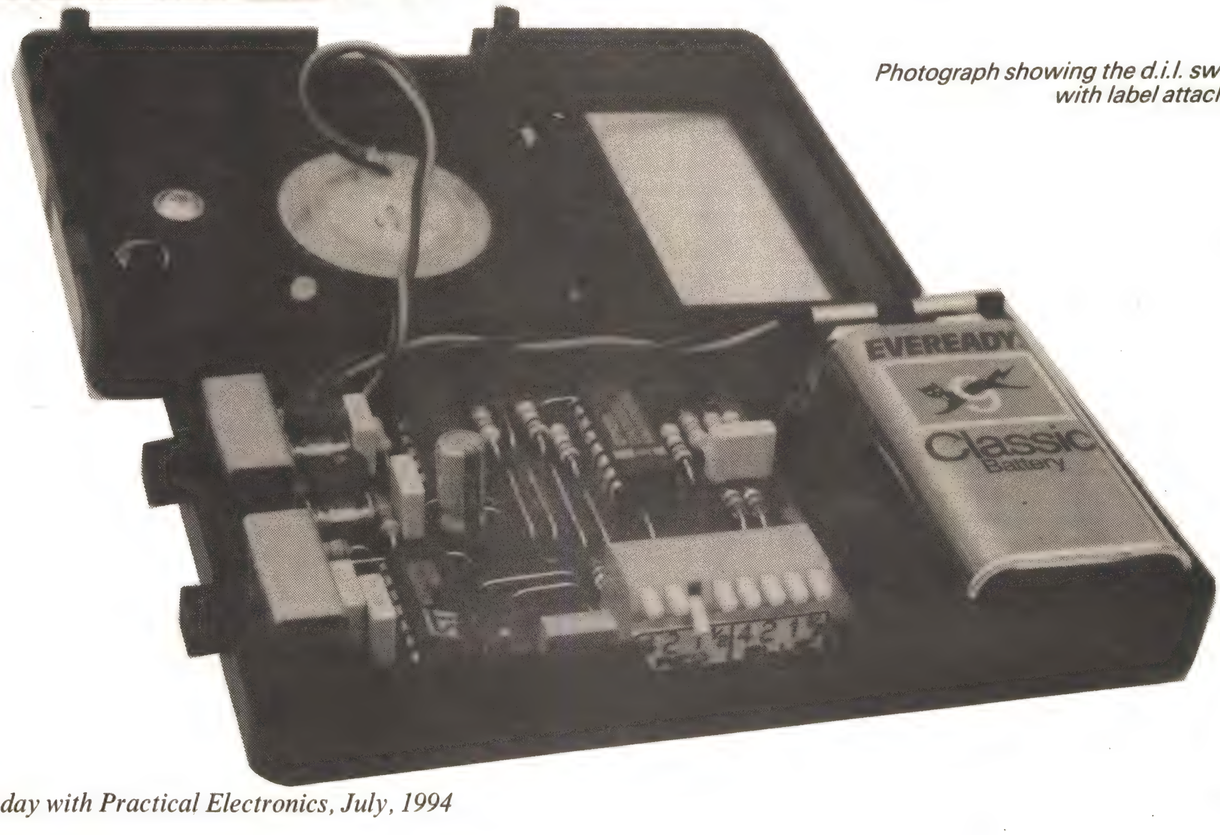


Fig. 5. Switch setting example.



Photograph showing the d.i.l. switch with label attached.

INTERFACE

Robert Penfold

IN THEORY, interfacing your own circuits to the expansion bus of a PC is pretty straightforward. Unlike many of the eight-bit home computers produced in the 1980s, the PC handles interfacing to add-on circuits in a largely standard fashion.

Despite this standard approach, there can sometimes be odd results when using your own PC add-ons. Over the last year or two I have received several letters from readers who have experienced odd problems with their PC interface projects, and I have also had one or two "out of computer" experiences myself. This month we will consider some possible problems and cures for PC add-ons that refuse to work reliably for no obvious reason.

Getting Physical

One potential cause of problems is a purely physical one. If you are making your own printed circuit boards to fit into the expansion slots of a PC, they must be made with a high degree of precision. Surprisingly perhaps, some ready-made expansion cards and some PC compatibles have connectors which do not match up accurately. I once owned a 286 PC AT compatible which would only work with about 50 per cent of the cards that were tried in it!

There are usually marks left on the expansion card's edge connector at the points where it comes into contact with the connector in the computer. If the two connectors do not match up properly, these marks should clearly show an offset.

In my experience the problem is not usually one of the two connectors having different terminal spacings, but is much more likely to be due to the expansion card being slightly offset from its correct position. This can result in a few missing connections between the two connectors, or it might even result in one or two short circuits between adjacent terminals of the connectors. If this should happen it is likely that the computer will cease to function while the card is fitted, rather than the card simply failing to work.

If an expansion card suffers from this offset problem it is usually possible to correct it by filing the appropriate edge of the card's connector. The card can then be carefully manoeuvred into the correct position. This might not be a particularly reliable solution though, and it would be better to rebuild the card on a new (and more accurate) printed circuit board.

Divide By Two

Even if everything in the computer is correctly connected to everything on the expansion card, there can still be problems for which there is no obvious explanation. I have never experienced any major problems when using computer interface chips such as the 8255, etc., but TTL chips seem to be a bit more problematic.

In particular, input and output ports based on devices such as the 74LS245, 74LS273, and 74LS373 can produce problems with reliability. This can be something quite slight, such as corrupt data being returned on about one out every ten readings from a port.

At the other extreme I have had output ports based on the 74LS273 which simply toggled the outputs on each write operation to the port! The 74LS273 was providing a divide by two action to the pulses received from the address decoder, rather than latching the data from the data bus of the computer.

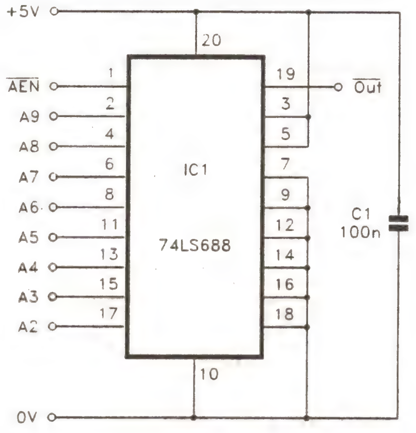


Fig. 1. A single chip PC decoder based on the 74LS688 8-bit comparator.

TTL integrated circuits are very intolerant of noise spikes on the supply lines. The general rule is that a circuit board should have one 100nF ceramic decoupling capacitor per four or five TTL chips. These supply decoupling capacitors should be fairly evenly distributed over the board.

It is noticeable that most ready-made PC expansion cards operate on the basis of one decoupling capacitor per TTL chip. Possibly the timing in PC interfacing is so critical that comprehensive supply decoupling of this type is essential.

Anyway, if a card based on TTL chips is proving to be something less than 100 per cent reliable, it would probably be worthwhile adding decoupling capacitors to any TTL chips that do not already have them. The extra capacitors can simply be wired across the supply pins of the chips on the underside of the board.

The capacitor leadout wires should be kept just long enough to reach between the two pins. It is advisable to use pieces of p.v.c. sleeving over the leadout wires to ensure that they do not accidentally short circuit to any of the other connections on the underside of the board.

The reliability of user add-ons is sometimes dependent on the speed of the host PC. At one time I used a "turbo" XT compatible computer to test add-on projects. At the normal clock speed of 4·77MHz there were normally no reliability problems, but at the 10MHz "turbo" clock speed things were much more critical.

This is perhaps only to be expected. More surprisingly, some turbo 386 and 486 PCs seem to be more easy going at their tubo setting than when used at a clock speed of 6MHz or 8MHz. This is made less easy to explain by the fact that the expansion bus timing is supposedly the same in the standard and "turbo" modes.

If an add-on is giving problems it might be worthwhile trying a different clock speed to see if this gives an improvement.

One Chip Decoder

Reliability seems to be improved if the address and control bus decoding is kept as simple as possible. In a previous *Interface* article I gave details of a single chip PC address decoder based on the 74LS684 8-bit magnitude comparator. This can decode up to eight address and control lines, but there is a similar device (the 74LS688) which can decode up to nine lines.

The two devices are very similar, but the 74LS688 lacks one of the outputs of the 74LS684. The missing output is not needed in address decoding applications incidentally. In place of this output the 74LS688 has a negative chip enable input. This can be used to decode one of the address or control bus lines to the low state.

The circuit diagram for a PC address decoder based on the 74LS688 is shown in Fig. 1. $\overline{\text{AEN}}$ is decoded by the negative chip enable input, and address lines from A2 to A9 are decoded by the eight normal inputs of IC1.

Pin 19 of IC1 goes low when the logic levels on A2 to A9 are the same as those set on the other eight inputs (provided the chip enable input is low). In this case the other eight inputs are hard wired to decode A8 and A9 to the high state, and the other six address lines to the low state. This gives the usual decoding to &H300, but as A0 and A1 are not decoded, using any address from &H300 to &H303 will activate the circuit.

In this form the address decoder is only suitable for use with an interface chip that provides decoding of $\overline{\text{IOR}}$ and $\overline{\text{IOW}}$. If this decoder is used with a TTL input or output port it must be modified so that it decodes either $\overline{\text{IOR}}$ or $\overline{\text{IOW}}$, depending on whether the port is an input or an output type.

The only way of achieving this without adding another chip is to decode the

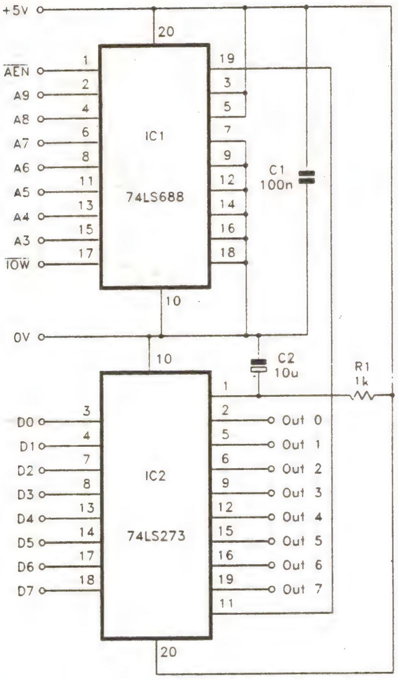


Fig. 2. An 8-bit latching output port for PCs.

additional control line instead of A2. A slight drawback of this method is that the add-on circuit is then placed in a block of eight addresses instead of a block of four.

This still enables up to four cards to be used in the block of 32 addresses allocated to prototype cards, so this is not a major problem. Also, bear in mind that it is quite acceptable for an input port and an output type to share the same address.

Table 1:

Address	Pin 16	Pin 14
&H308	+5V	0V
&H310	0V	+5V
&H318	+5V	+5V

Port of Call

The circuit for an 8-bit output port based on a 74LS688 single chip decoder is shown in Fig. 2. IC2 is an octal D-type flip/flop. The data on the data bus is latched onto IC2's outputs on the trailing edge of each pulse from IC1.

The circuit of Fig. 3 is for an 8-bit input port based on the same decoder, but as this is an input port it is $\overline{IOR}$ that is decoded, not $\overline{IOW}$.

A 74LS245 octal transceiver i.c. is used for IC2, but in this circuit it is used as a simple tristate octal buffer. Its outputs are activated during the output pulse from IC1, and it then places the input data onto the data bus so that it can be read by the microprocessor.

In practice, both of these ports seem to be less pernickety about supply decoupling, bus speed, etc. than similar ports based on a different address decoder. If you are having difficulty in getting good reliability from your PC with user add-ons it would almost certainly be worthwhile trying out a decoder based on the 74LS688. So far, I have not had any problems with this decoder, even in situations where other decoders failed to give perfect results.

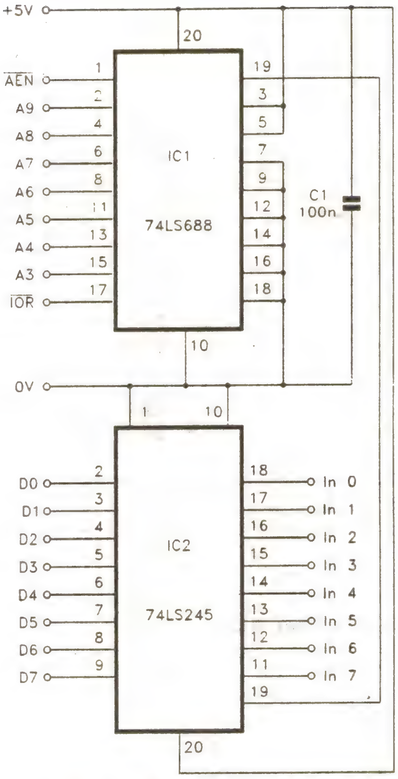


Fig. 3. The PC 8-bit input port.

The connections shown in Fig. 2 and Fig. 3 are for a base address of &H300, but there are three other base addresses available. If you wish to use one of these alternative base addresses the connections to pins 14 and 16 of IC1 should be amended, as detailed in Table 1.

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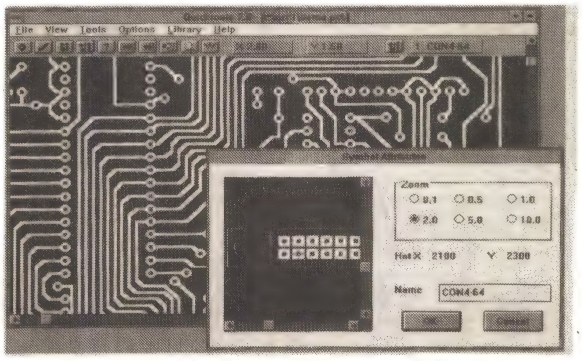

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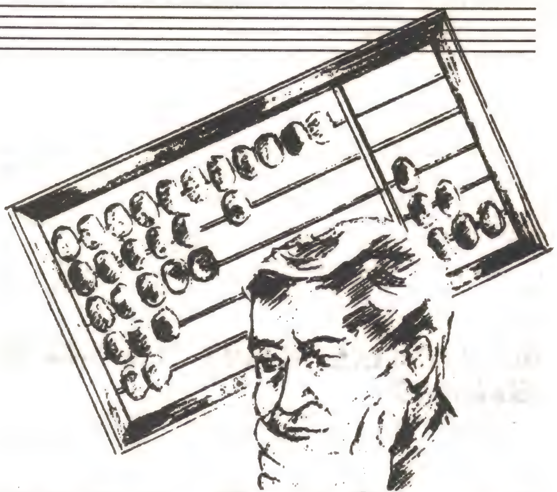

STEVE KNIGHT

Part Seven

This series is designed to help you make your way, at your own pace, through the often imagined fears of mathematics, as this is applied to electronic and electrical engineering matters.

WHEN I was a student many years ago, mentioning decibels in just about every sentence was a general method of those who knew it all to put firmly in their places those of us who knew nothing. The more cynical among us used to call it talking in Decibelese. This verbal flourishing still goes on in some places as my own long experience has shown me. Certain other words also make their appearance from time to time, often during interviews, to create the impression that the interviewee had better submit without argument to the obviously superior powers of his interrogator.

This month therefore, we take a look at the decibel and reveal that it is not such a highfalutin symbol of electronic erudition as some would have us believe.

POWER RATIOS

Decibel notation is, in very general terms, a convenient means of dealing with the ratios of powers, voltages and currents which are present in electronic and electrical systems. If an amplifier, say, has a 1mV input signal and this results in a 1V output signal, we can say that the amplifier has a **voltage gain** of 1,000 times, since 1,000 × 1mV = 1V. Again, our amplifier may present us with a 10W output for a 5mW input, and here we may say that it has a **power gain** of 2,000 times, since 2,000 × 5mW = 10,000mW or 10W.

Gains (and losses) of many millions of times are commonplace in electronic and communication work and such an enormous range of powers, voltages and currents are usually expressed in a simpler and less unwieldly mathematical form using logarithmic units. Addition then takes the place of multiplication and subtraction the place of division, for hopefully we recall that $\log(A \times B) = \log A + \log B$ and $\log(A \div B) = \log A - \log B$. But don't worry if this seems an intimidating start to things; the following worked examples should soon set things into perspective.

1. What is the overall power ratio of a three-stage amplifier whose stages have power ratios of 8, 0·5 and 15? What input is necessary to provide a 1W output?

The amplifier is shown in a block diagram in Fig. 7.1. There seems to be a preamplifier stage giving a power gain of 8 times, followed by possibly a tone control system which introduces a power loss (since the "gain" here is only 0·5 times) and then finally a power output stage giving a gain of 15 times. These three stages are said to be in **tandem** or **cascade**.

The overall gain ratio is found simply as the product of the individual gains since

$$\frac{P_0}{P_1} = \frac{P_2}{P_1} \times \frac{P_3}{P_2} \times \frac{P_0}{P_3}$$

and P_0/P_1 is the overall ratio we want. Hence

$$\frac{P_0}{P_1} = 8 \times 0{\cdot}5 \times 15 = \mathbf{60\ times}$$

So the power output $P_0 = 60 \times$ power input P_1. For a 1W output then

$$P_1 = \frac{1}{60} \times P_0 = \frac{1\text{W}}{60} = 0{\cdot}0167\text{W or } \mathbf{16{\cdot}7mW}$$

DECIBEL GAINS

If the ratio of two powers P_0 and P_1 is to be expressed in decibels, (dB), the number of decibels, N, is given by

$$N = 10 \log\left[\frac{P_0}{P_1}\right] = 10 \log\left[\frac{\text{power output}}{\text{power input}}\right] \text{dB}$$

although the two power levels do not necessarily have to be those at the input and the output of an electronic system, as we shall see later on.

So we simply have to find the common logarithm of the power ratio and multiply by 10, a calculation easily done on our basic calculator.

2. What is the power gain of the amplifier in the previous example expressed in dB?

   Well, the power gain ratio was 60, hence $N = 10[\log 60]$dB

On our calculator we now use the **log** button, **not** the **ln** button as we did in last month's calculations. So enter 60, press the log button and 1·778 ... is displayed. Now multiply by 10 in the usual way and we get $N = 10 \times 1{\cdot}778 = \mathbf{17{\cdot}78dB}$.

Unless we were looking for great precision for any reason, the above answer would be rounded off to 18dB.

Get used to this operation by finding the dB equivalents of, say, power ratios of 5, 10, 15, 20, 25 and 30 times. The answers are at the end of the text.

ATTENUATION

Suppose we are reducing the power input to a device by means of an attenuator, then what meaning do we attach to a decibel loss? We try an example to illustrate:

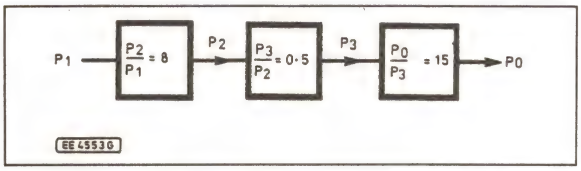

Fig. 7.1. A simple three-stage amplifier showing the power ratio in each stage.

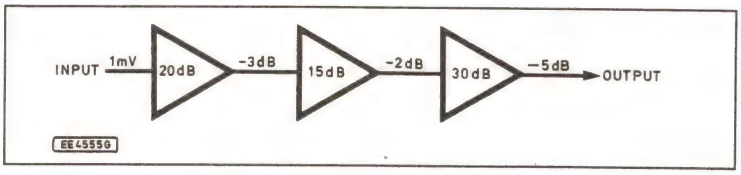

Fig. 7.2. A three-stages-in-tandem amplifier which introduces losses in the interstage coupling.

3. The power input to an attenuator is 0·5W and the output is 0·12W. What is the power loss in dB?

Here the power ratio is fractional since P_0 is *less* than P_I

$$N = 10 \log \frac{0{\cdot}12}{0{\cdot}5} = 10 \log 0{\cdot}24$$

Going through the procedure on the calculator we find that log 0·24 = −0·62. This is no surprise since the logarithm of *any* positive fraction less than unity is negative.

Hence we have $N = 10x(-0{\cdot}62) = $ **−6·2dB**

and the power loss is indicated by the appearance of the negative sign. It is customary to say that the system gain is **6·2dB down** or, as telecommunication engineers say, **neg 6·2**.

VOLTAGE AND CURRENT GAINS

Suppose that the input and output resistances (or loads, if you wish) of an amplifier or network are equal, then the ratio of the output to the input power can be found either in terms of the output and input voltages or in terms of the input and output currents. For since the power dissipated in a resistance R is given by

$$P = \frac{V^2}{R} = I^2R$$

we have
$$\frac{P_0}{P_I} = \left[\frac{V_0}{V_I}\right]^2 = \left[\frac{I_0}{I_I}\right]^2$$

since the R's cancel out. Therefore, if we express the power ratio in decibel form we get

$$10 \log \frac{P_0}{P_I} = 10 \log \left[\frac{V_0}{V_I}\right]^2 = \log 10 \left[\frac{I_0}{I_I}\right]^2$$

$$= \log 20 \left[\frac{V_0}{V_I}\right] \text{ or } 20 \log \left[\frac{I_0}{I_I}\right]$$

That is, Power gain = 20 log (voltage gain) dB
= 20 log (current gain) dB

We can use either of these expressions depending upon whether we want voltage or current gains. It is more general to work in terms of voltage even if the input and output resistances are not equal, which is most often the true situation. Strictly, this is an inaccurate procedure but it is an accepted convention. The decibel is used to express voltage gain or loss and *not* to compare input and output powers. Thus an amplifier whose output voltage is 35 times the input voltage has a voltage gain of 20 log 35 = 31dB.

Keep in mind that a voltage or current gain expressed in dB is *twice* the corresponding power gain in dB. From now on we will symbolize power gain, voltage gain and current gain as A_p, A_v and A_i respectively.

4. Calculate the current gain in dB of a network having an input current of 250μA and an output current of 15μA.

$$\text{Current gain} \quad A_i = 20 \log \left[\frac{I_0}{I_I}\right] = 20 \log \left[\frac{15}{250}\right] \text{dB}$$

$$= 20 \log 0{\cdot}06 = 20 \times (-1{\cdot}22) \text{ dB}$$

$$= \mathbf{-24{\cdot}4\ dB}$$

Make sure in examples like this that the currents used in the ratio I_0/I_i are in *like* units; in the above both were given in microamps.

5. Express 30dB as a voltage ratio.

Here we are given the dBs and we have to find the ratio. We know that

Voltage gain $A_v = 20 \log (\text{ratio})$ dB

Hence $30 = 20 \log (\text{ratio})$ dB

and so $\log (\text{ratio}) = \frac{30}{20} = 1{\cdot}5$

We now want to find the number (the ratio) whose logarithm is 1·5, that is, we want the *antilog* of 1·5.

Our calculator can again solve the problem for us. You will not find an antilog button marked as such on the keyboard, so what we have to do in all cases such as this is to raise the base of the logarithm (which is 10) to the number of decibels (which here is 1·5). There are two approaches, and some calculators have buttons for both of them. You can use the y^x button or the 10^x button; I will describe the former of these. We have

$$\text{voltage ratio} = \text{antilog } 1{\cdot}5 = 10^{1{\cdot}5}$$

and we have to find $10^{1{\cdot}5}$

Enter 10, press the y^x button, enter 1·5, then =. The answer should be given as 31·6. Hence the output of this amplifier is **31·6 times** the input voltage.

If you use the 10^x button, you will avoid having to enter the 10 initially, but some calculators do things in reverse orders so you had better refer to your instruction booklet if you decide to use this method.

6. Fig. 7.2 shows an amplifier system in which each active stage provides a positive voltage gain while the interstage couplings introduces losses. What is the output voltage of this system?

Here we see one of the advantages of the decibel system.

Total amplifier gain = (20 + 15 + 30) = 65dB

Total amplifier loss = −(3 + 5 + 2) = −10dB

Overall gain A_v = gains − losses = 65 − 10 = 55dB

∴ 55 = 20 log (voltage rato) dB

or 2·75 = log (voltage ratio)

∴ voltage ratio = $10^{2{\cdot}75}$ = 562 times

Hence the output voltage of the system is 562 times the input voltage. The input is given as 1mV, hence the output is 562mV or **0·562V**.

7. In a common-emitter amplifier a signal input voltage of 10mV produces an output current of 2mA in a 470Ω load resistor. If the input resistance of the amplifier is 1kΩ, find A_v, A_i and A_p of this circuit in dB.

Follow the working of this example carefully from Fig. 7.3.

At the output, 2mA flows in 470Ω, hence the output voltage $V_0 = 2 \times 10^{-3} \times 470 = 0{\cdot}94$V

$$\therefore \quad \text{voltage ratio } \frac{V_0}{V_I} = \frac{0{\cdot}94}{10 \times 10^{-3}} = 94 \text{ times}$$

and the voltage gain in dB = A_v = 20 log 94 = **39·5dB**

$$\text{The input current} \quad I_I = \frac{V_I}{R_I} = \frac{10 \times 10^{-3}}{1{,}000} = 10\mu\text{A}$$

$$\therefore \quad \text{current ratio } \frac{I_0}{I_I} = \frac{2 \times 10^{-3}}{10 \times 10^{-6}} = \frac{2 \times 10^3}{10} = 200 \text{ times}$$

and the current gain in dB = A_i = 20 log 200 = **46dB**

Now power ratio = (voltage ratio) × (current ratio)

= 94 × 200 = 18,800

Hence power gain = A_p = 10 log 18,800 = 10 × 4·27

= **42·7dB**

You will appreciate, of course, that when we talk about inputs and outputs to amplifiers, we are actually referring to *a.c. signals*, not d.c. values. We will be going into some elementary a.c. theory later in the series.

BANDWIDTH MEASUREMENTS

We can introduce decibels to a measure of bandwidth by means of a simple example:

8. How many dBs is equivalent to (a) doubling, (b) halving the input power to a system?

If the power is doubled, the power ratio is clearly 2 times. Hence A_p = 10 log 2 = 10 × 0·301 = 3·01dB, which can be rounded down to a convenient 3dB. This is an often quoted power gain.

If the input power is halved, the power ratio is 0·5 and the dB gain is 10 log 0·5 = 10 × (−0·301) = −3dB.

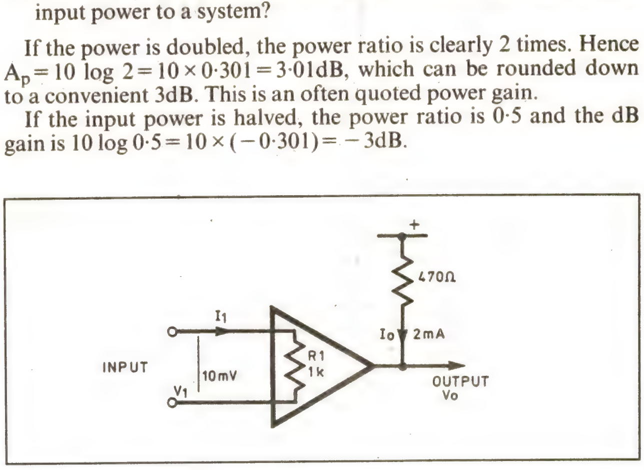

Fig. 7.3. An amplifier problem.

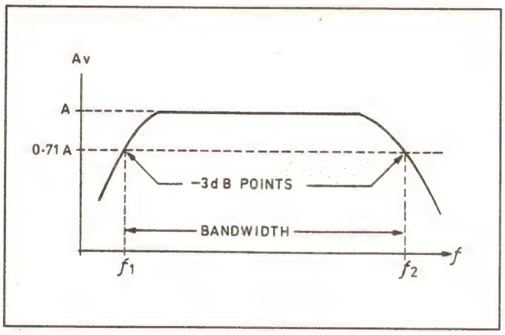

Fig. 7.4. Gain-frequency response showing the meaning of bandwidth curve of an audio amplifier.

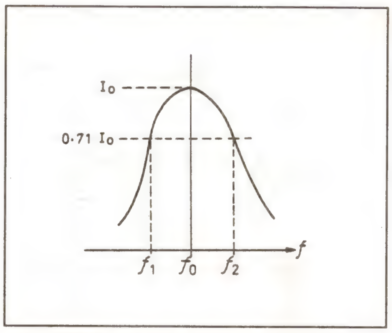

Fig. 7.5. Response curve of a tuned resonant circuit.

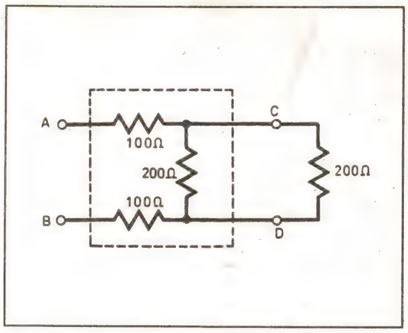

Fig. 7.7. A problem of attenuation.

Now Fig. 7.4 shows a gain-frequency response of a typical audio amplifier system. This is a graph of amplifier voltage gain A_v against frequency f. We see that the gain is substantially constant over most of the audio range but drops away at the low and high frequency ends of the spectrum because of the influence of the interstage coupling characteristics. The −3dB points or the **half-power points** are defined as the points at which the voltage gain falls to 0·71 (actually $1/\sqrt{2}$) of its maximum value. This follows because we know that power gain = 20 log (voltage gain) and here the power gain is −3dB.

Hence $\quad \log(\text{voltage ratio}) = -\dfrac{3}{20} = -0·15$

and so $\quad \text{voltage ratio} = 10^{-0·15} = 0·71$ times

The frequencies corresponding to these points define the **bandwidth** of the amplifier; hence bandwidth $B = f_2 - f_1$ as Fig. 7.4 shows, these being the points where the voltage has fallen to 0·71 (or 71%) of its mid-band value.

The same applies to a resonant circuit curve as illustrated in Fig. 7.5 which shows the variation in current in a series tuned L-C circuit. Unless there are special reasons for the contrary the bandwidth is always stated with reference to the half-power points where, in this case, the peak resonant current has fallen to 71% on either side of resonance. This choice does away with any arbitrary level for a measure of the bandwidth and so enables a definite figure to be obtained for the ratio $f_0/(f_2 - f_1)$ which is a measure of the circuit selectivitily, f_0 being the resonant frequency.

That will be enough for this month, so here are the in-text solutions and some self-assessment examples to keep you quiet for an hour or so. Answers next month as usual.

7dB, 10dB, 11·7dB, 13dB, 14dB, 14·8dB

PROBLEMS

1. Express the following power ratios in dB: (a) 2·5, (b) 12, (c) 100, (d) 600.
2. Calculate the voltage gain of an attenuator network which provides an output of 20μV for an input of 300μV.
3. Complete the following statements: (a) +20dB with respect to 1W is a power level of . . . W, (b) +12dB with respect to . . . mV is a voltage level of 4mV.
4. A cable has a power loss of 12dB per kilometer length. What will be the dB loss over a length of 680 metres?
5. In Fig. 7.6, an input of 0·6V is maintained across points AB. What is the voltage across the load CD? What is the reduction in the output power attributable to the network contained within the broken lines? Give your answer in dB.
6. An amplifier consists of four stages, each of which has a voltage gain of 20 times. What is the dB gain of each stage and what is the total gain in dB?
7. Fig. 7.7 shows an idealized response curve of an amplifier. What (approximately) is the bandwidth of this amplifier? (Note that the frequency scale is divided logarithmically).
8. The advantage of the decibel unit is that when the response of an amplifier is plotted in dB against frequency, the overall response of a multistage amplifier can be obtained by adding the individual response curves. Is this statement true or false?

Last month's answers: 1. 696V; **2.** (a) 2·24s, (b) 406kΩ **3.** (a) 31·9s, (b) 0·033s, (c) 1551μs, (d) 2·21μs; **4.** (a) 10V, (b) 100V, (c) 1,000μC = 1mC, (d) 100μA; **5.** (a) 5·55V, (b) 9·45V; 0·2mA; **6.** 1·079s; **7.** 50mA, 15·625mC, 9·375mC, 312·5V

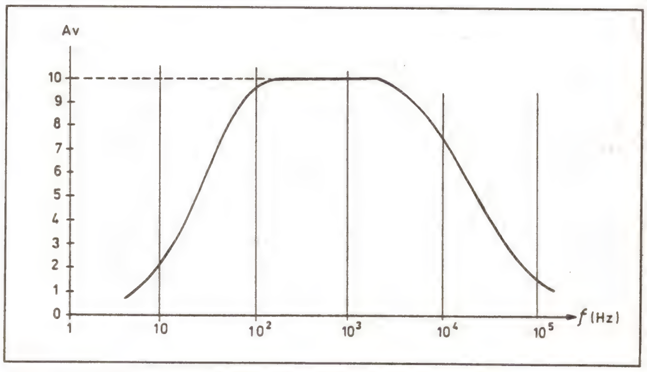

Fig. 7.7. What is the bandwidth of this amplifier?

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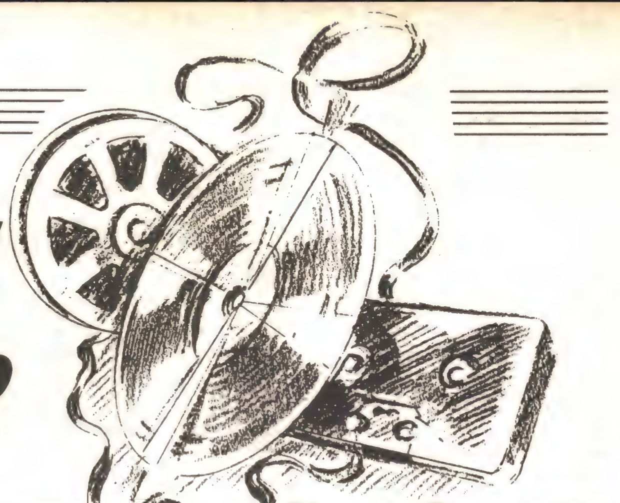

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This design is intended to accept inputs from typical sources – see Fig. 1 – using the existing preamplifiers' phono pre-amp and RIAA equalisation for the phono input. The unit defaults to a background input (e.g. tuner) in the absence of a signal on any of the four priority inputs.

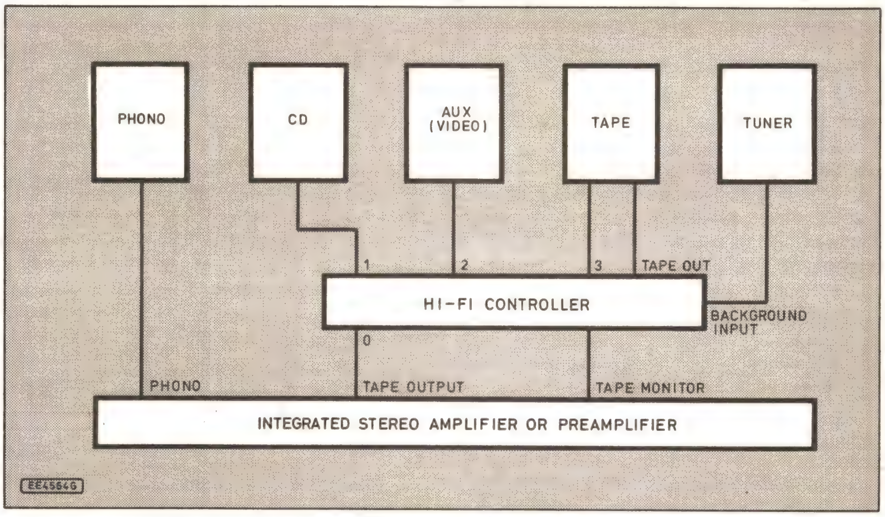


Fig. 1. System input block diagram. Note: select phono and tape on preamplifier.

OVERVIEW

An early prototype had only one Priority input and a Background input. The priority input was highly amplified, rectified, and the resultant signal used to charge a capacitor. The potential difference across the capacitor was used to control a Voltage Controlled Amplifier (VCA).

When configured as outlined above, a priority signal would cause the gain of the VCA to reduce to almost zero, thereby fading out the background source. When the priority audio signal ceased, the charge on the capacitor would gradually fall, the VCA gain would increase, thereby fading the background source back in.

This system suffered from two problems: First, the priority input was not faded in, which gave an "unpolished" impression of the design. Second, and more importantly, quiet passages in music, particularly at the beginning, would not adequately charge the capacitor, leading to the background input being continually audible and therefore a nuisance.

The answer to the first problem is obvious: Introduce a second VCA to control the Priority input, operating on an exclusive-OR basis with the existing VCA.

However, the second problem ultimately required the design of a "digital monostable" to achieve a consistent, reliable result. This comprises a 4093BE Schmitt trigger, astable multivibrator, counter and flip-flop. Fig. 2 shows a block diagram for this part of the unit.

The priority input audio signal is amplified so it will trigger the Schmitt. The resulting pulses are used to set a flip-flop and also reset a counter, keeping the counter at zero. The counter is a 4017 type with the "9" output used to reset the flip-flop.

Consequently, when there is no audio signal present, the lack of pulses from the

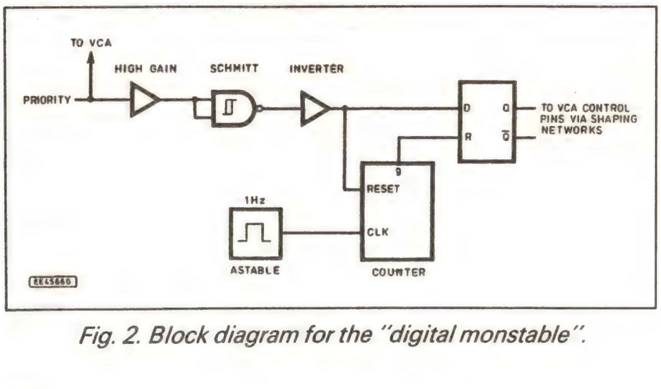


Fig. 2. Block diagram for the "digital monstable".

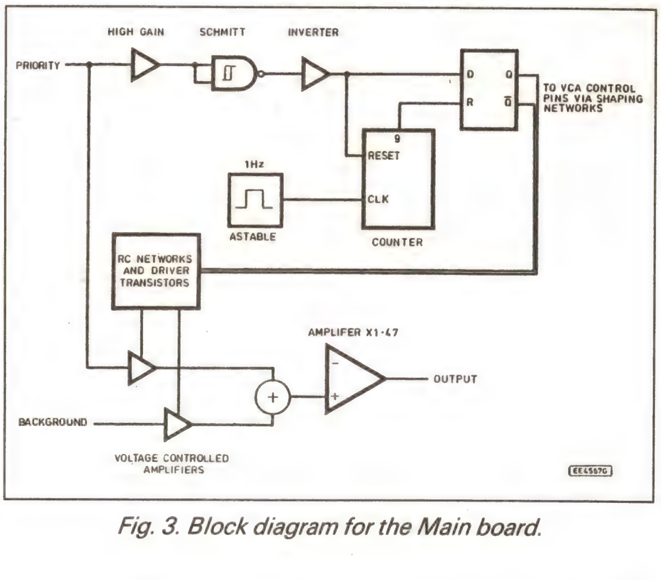

HIGH GAIN
SCHMITT
INVERTER
PRIORITY
D
Q
R
Q̄
TO VCA CONTROL PINS VIA SHAPING NETWORKS
9
RESET
1Hz
CLK
ASTABLE
COUNTER
RC NETWORKS AND DRIVER TRANSISTORS
AMPLIFER X1·47
OUTPUT
BACKGROUND
VOLTAGE CONTROLLED AMPLIFIERS
EE4567G

Fig. 3. Block diagram for the Main board.

Schmitt allows the counter to reach nine, resetting the flip-flop. At a clock frequency of 1Hz, this means a delay of 10 seconds from the end of the priority signal to the background being faded in.

The complimentary outputs of the flip-flop are ultimately used to control two VCA's, providing the mutual exclusivity required. The inverter is required because the specified Schmitt is a NAND type. It is easily fabricated from a spare gate within the same 4093BE package.

USING THE MAIN BOARD ONLY

The block diagram of the Main circuit board is shown in Fig. 3. This will operate as a "stand-alone" project, with one Priority input, one Background input, plus connections for the stereo output and power supply. It is eminently suitable for inclusion in some other project as a "building block".

The Expansion board to be described next month increases the number of Priority inputs to four by scanning each in turn and feeding them to the priority input on the Main board (Fig. 4). A "trigger" output from the Main board stops the scan when a signal is found.

An additional feature with the Expansion board is a Tape output which can select from any of the four priority inputs independently of the Main board. A dual seven-segment display indicates scanning status, source selected if any, and the tape source selected.

ARTICLE STRUCTURE

The very nature of this Controller project, with the ability to build and use the Main board on its own, lends itself to being described in three sections – Power Supply; Main Board; and Expansion and Display Boards.

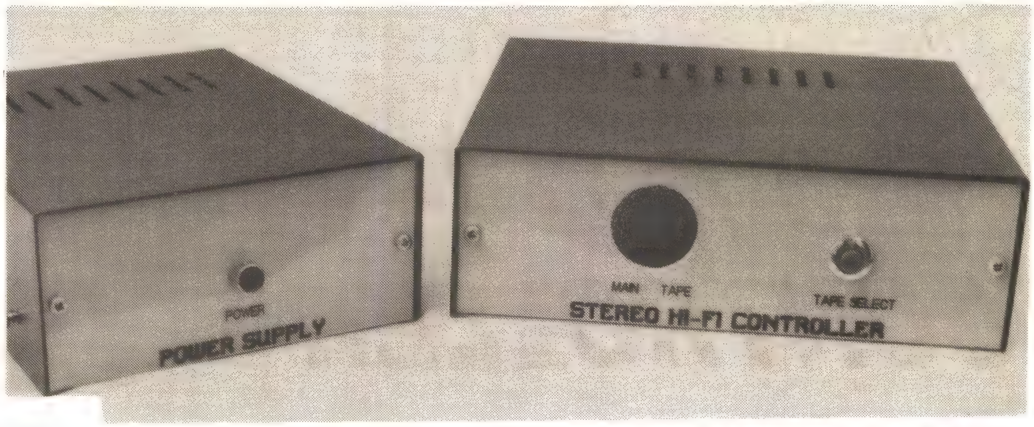
POWER SUPPLY

The power supply (PSU) for the Stereo HiFi Controller project is of a straightforward series-regulator design. However, a couple of points are worthy of further explanation.

First, it is wise to fit a fuse on the mains side of 100mA or even less. Also, the transformer specified is rated at 250mA, which is in excess of the 120mA or so required. At this size, the cost advantage of dropping to a smaller transformer is minimal, while the advantages of using a larger one than required (heat, regulation, future expansion) are obvious.

The output of the PSU is +/−7·5V, +/−7V after the protection diodes on the Main board (described later). This unusual level is due to the mix of i.c.s on the main and expansion/display boards; CMOS works from 3V to 18V, ideally 5V to 15V. The LM13700 is fine from +/−2V to +/−18V, and the LF347 from +/−5V to +/−18V.

This PSU provides 14V for the CMOS and mid-range for the op.amps; +/−9V would give 18V for the CMOS (right at the top end), +/−6V or +/−5V are a little on the low side for the LF347. Unfortunately, the 79- and 78- series regulators provide 5V or 9V only, and although they could be used with a little extra design work, this back-to-basics design is inexpensive and effective.



The completed power supply unit and the controller. The cutout on the controller front panel is for the dual display.

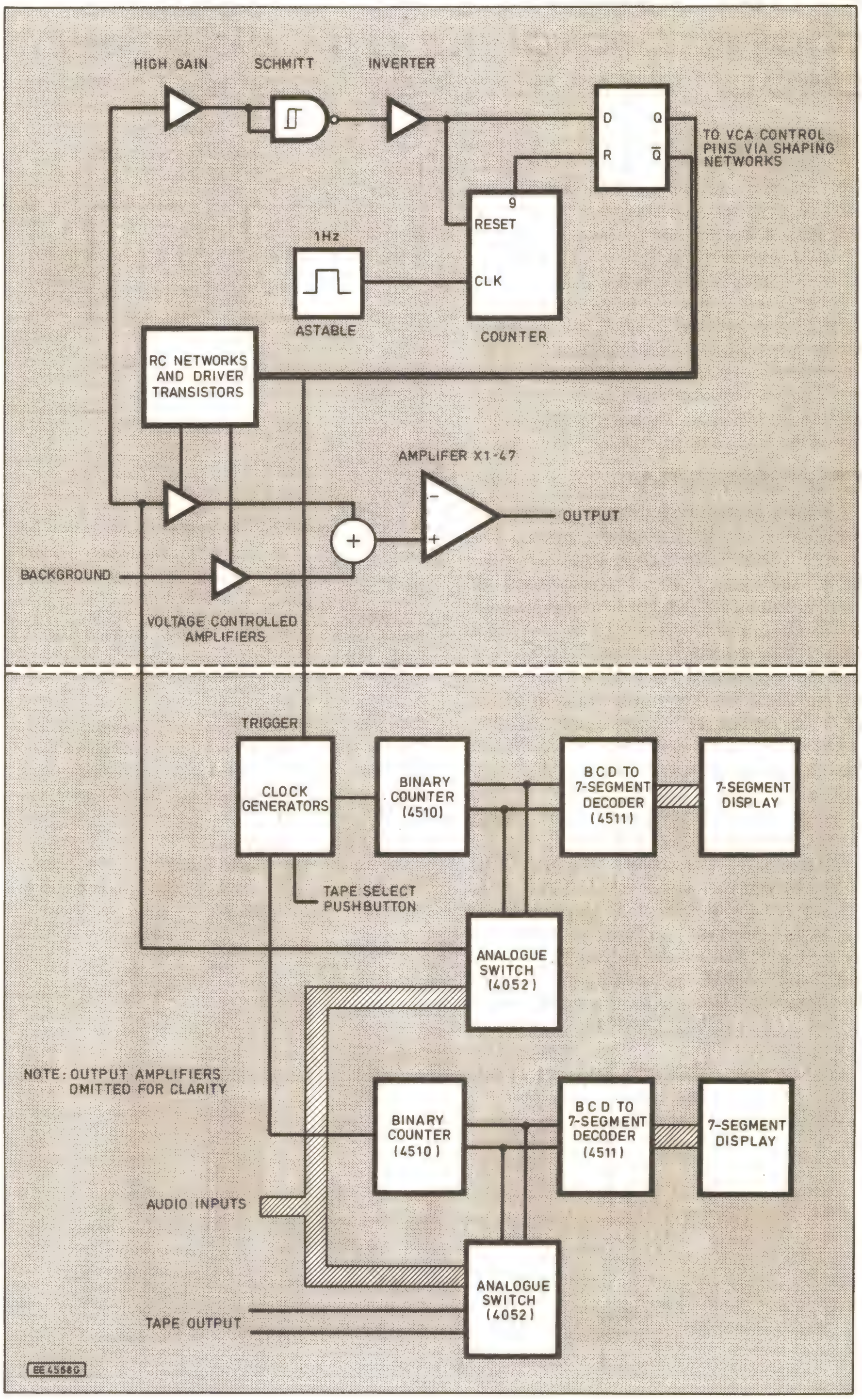


Fig. 4. Complete system block diagram. The Expansion Board is the lower section of the diagram.

HOW IT WORKS

The Power Supply circuit diagram for the Controller is shown in Fig. 5. The low voltage a.c. from the transformer secondary winding is rectified by the bridge rectifier REC1 and smoothed by capacitors C1 and C3.

Transistor TR1, resistor R1, Zener diode D1, diode D2 and TR2, R3, D3, D4 form series regulators providing an output voltage equal approximately to that of the Zener diodes, since the voltage drop across TR1, TR2 is offset by diodes D2, D4. Further smoothing is achieved by capacitors C2 and C4. Resistor R2 limits the current through the red light emitting diode D5.

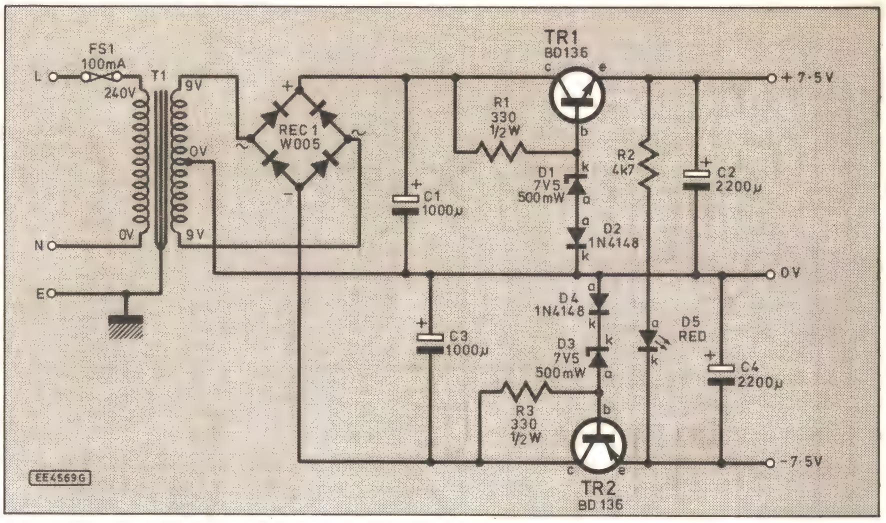


Fig. 5. Power supply circuit diagram for the Controller.

CONSTRUCTION

The PSU is built in a separate metal case to reduce hum/noise, and as an aid to construction and testing. The only danger is that of connecting the supply the wrong way round, which can be expensive! The two diodes on the Main board prevent damage, hence the +/−7·5V output of the PSU to compensate.

The prototype used a 3·5mm stereo jack for the supply, and the diodes eliminate any concern with temporary incorrect

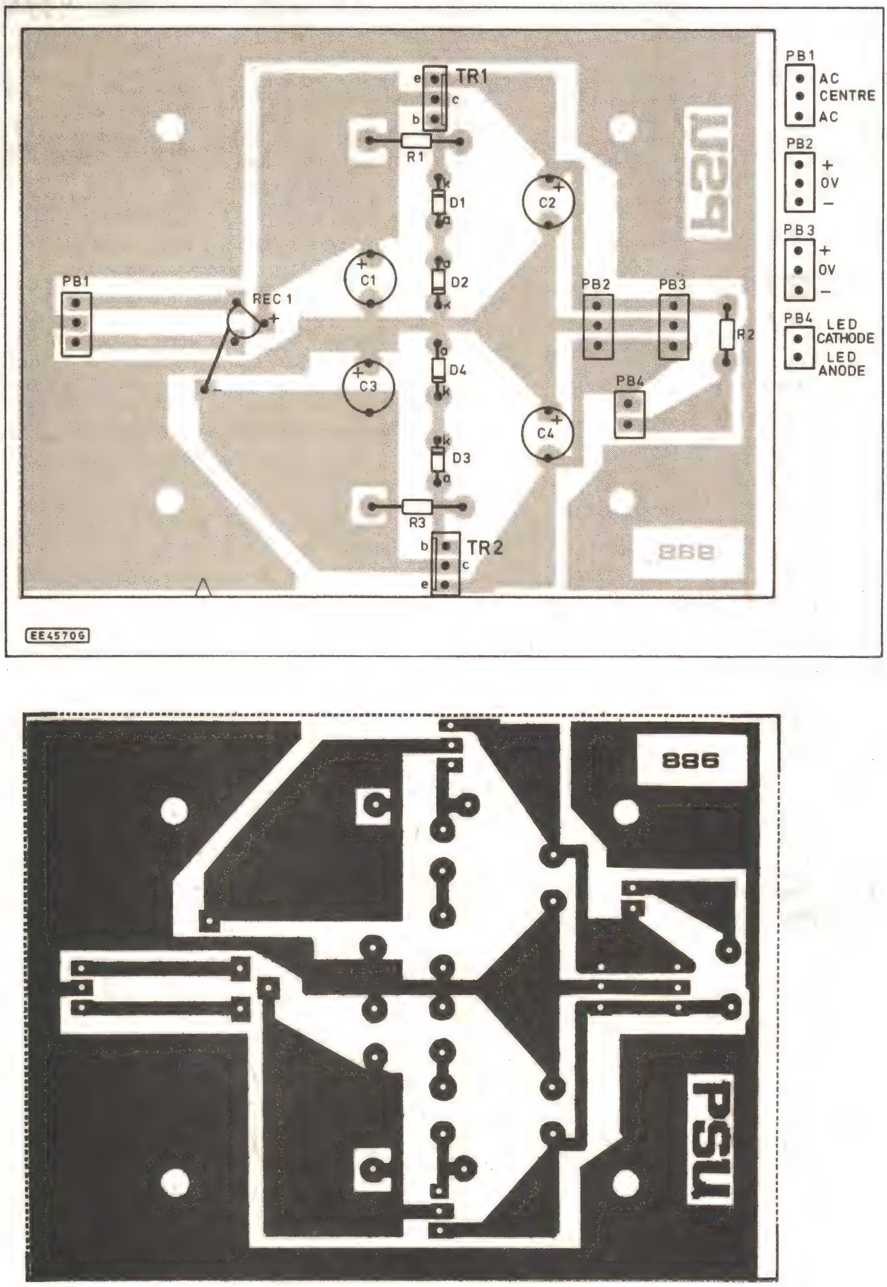


Fig. 6. Printed circuit board component layout and full size copper foil master pattern. The p.c.b. connector pin details are shown top right.

COMPONENTS

POWER SUPPLY UNIT

See SHOP TALK Page

Resistors

R1, R3	330 (2 off)
R2	4k7

All 0·6W 1% metal film

Capacitors

C1, C3	1000µ radial elect. 25V (2 off)
C2, C4	2200µ radial elect. 16V (2 off)

Semiconductors

D1, D3	7·5V 500mW Zener diode (2 off)
D2, D4	1N4148 signal diode (2 off)
D5	5mm red l.e.d.
TR1	BD135 *npn* power transistor
TR2	BD136 *pnp* power transistor
REC1	W005 1·5A 50V bridge rectifer

Miscellaneous

T1	250mA min. mains transformer. Primary 240V a.c. Sec. 9V-0V-9V r.m.s.
FS1	100mA fuse, with chassis mounting fuseholder
SK1, SK2	3·5mm chassis socket (2 off)

Steel Metal case, size 125mm x 155mm x 58mm; printed circuit board available from the *EPE PCB Service*, code 886 (p.s.u.); 2-way p.c.b. connector, with latch housing and terminals; 3-way p.c.b. connector, with latch housing and terminals (3 off); 2-way mains screw terminal block; p.c.b. stand offs (4 off); l.e.d. chrome bezel; Earth tag; connecting wire; insulating sleeving; mains cable gland; cable ties and bases; solder; nuts, bolts etc.

Approx cost guidance only **£25**

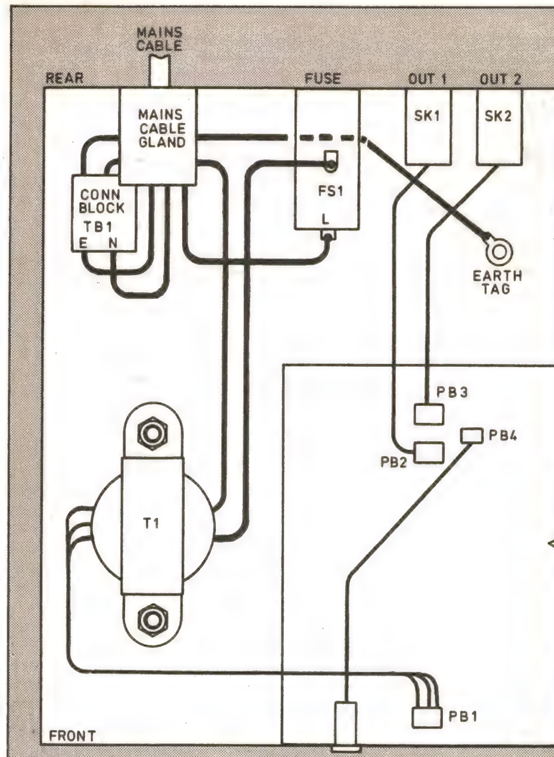
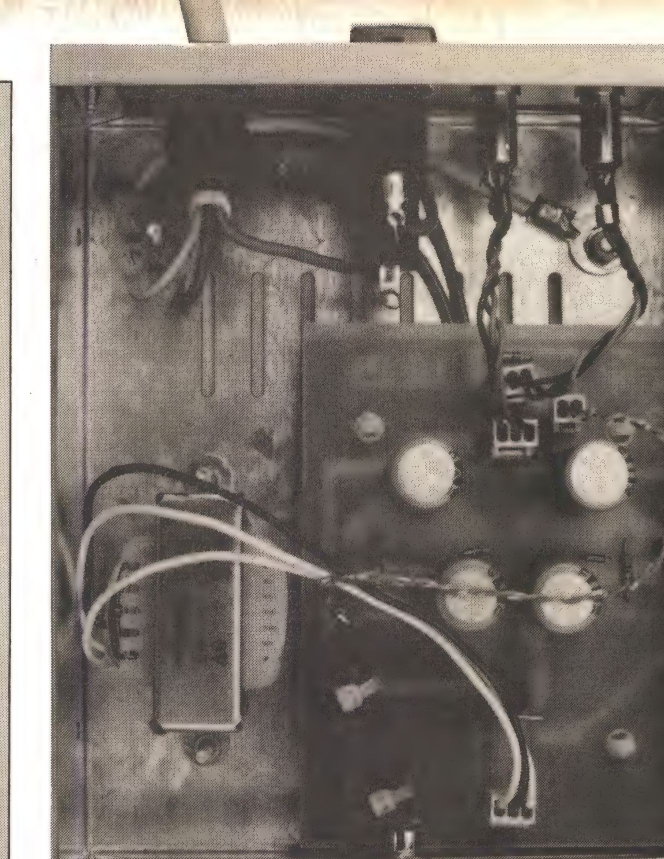
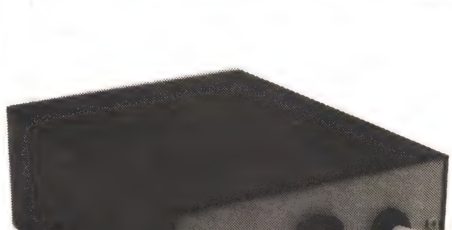


Fig. 7. Power supply interwiring details.



The complete PSU. Note the "earth" tag bolted to the metal case.



Rear view of the power supply showing the output sockets.

polarity if the plug is inserted with the PSU switched on.

Construction of the PSU is very straightforward – follow the usual rules regarding orientation, etc. The printed circuit board (p.c.b.) component layout and full size copper foil master for the Power Supply is shown in Fig. 6. This board is available from the *EPE PCB Service*, code 886.

It is recommended that the capacitors be left until last as they are relatively large. The specified p.c.b. connectors should also be used as they make for a very neat job and allow easy removal of the board if necessary.

Secure the mains carrying primary transformer leads with cable ties and self-adhesive bases so there is no risk of them "floating" towards the underside of the p.c.b.

If you use the specified case, a small notch may be required in the p.c.b. to accommodate one of the lid securing screws. The component layout inside the case and interwiring is shown in Fig. 7. Be careful to connect the incoming mains live (L) lead to the rear of the fuseholder!

TESTING

DUE TO THE PRESENCE OF MAINS VOLTAGES, EXTREME CARE MUST BE TAKEN WHEN TESTING THE POWER SUPPLY. ***Double check all wiring before proceeding further.***

If all looks well, apply mains power to the unit. The l.e.d. D5 should light. If it doesn't, check for 18V a.c. across the bridge rectifier input terminals. If it is there, you need to check your p.c.b. If it isn't, check the mains wiring, fuses, etc.

Turn off, the l.e.d. should stay on for 15 seconds or so. If it doesn't, check the p.c.b.

Test the voltage across the bridge rectifier output, it should be just over 24V. Test the output of the PSU, which should be +/−7·2V to +/−7·5V.

This circuit is so simple that it is unlikely any problems will arise which are caused by other than poor soldering, faulty components, or, of course, incorrect placement. If all is OK, fit the top cover and move on to the rest of the project.

CIRCUIT - MAIN CONTROL BOARD

The Main Control board can be built as a stand alone project, or used with the Expansion Board described later with some minor component changes. The circuit diagram for the Main Control Board is shown in Fig. 9.

The LM13700 (IC1 and IC2) is a dual operational transconductance amplifier, and offers reasonable performance in this configuration as a VCA. The gain is controlled by a bias current applied to pins 1 and 16.

The chip features an extra transistor output stage which is used to provide a low impedance output – see pinout outline and internal details Fig. 8. The in depth operation of these amplifiers is beyond the scope of this article, and would refer interested parties to Ray Marston's book, *Op-Amp Circuit Manual*.

The Background Input is subject only to VCA control; the Priority Input is also fed to a stereo buffer, mixer and amplifier (mixing both channels with resistors leads to poor crosstalk). The use of a quad op.amp allows for easy implementation of a stereo buffer and an economical realisation of a stable, high gain, easily gain-adjustable amplifier.

It is not necessary to achieve a high degree of audio perfection for the purposes of triggering the Schmitt, therefore the inexpensive LF347N is ideal. A 4093 i.c. is used both for signal detection and clock generation for the 4017 (IC6). The counters' ten sequential outputs makes interconnection to the 4013 flip-flop (IC5) straightforward.

The fading characteristic of the VCA's is set by R52/C21, and R53/R54/D6/C22. A great deal of time was spent trying different combinations before settling on

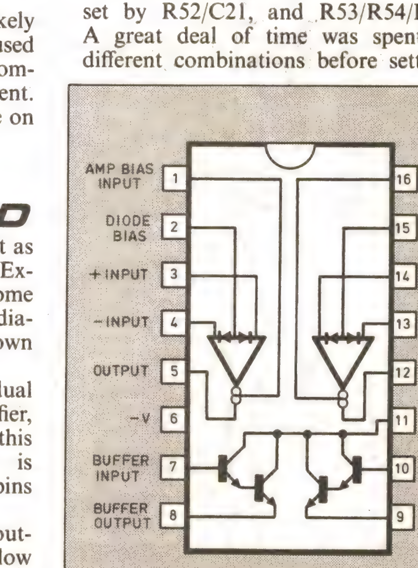


Fig. 8. Pinout details for the 13700 transconductance op.amp.

these values, but they can, of course, be varied to preference.

Some gain, as well as buffering, is provided by IC7. Overall gain of the board is adjustable (more on which later), and this amplifier provides a stable, low impedance output.

HOW IT WORKS

The Priority input is fed to a VCA input, IC2. In addition, left and right signals are buffered by IC3a and IC3b before being mixed and amplified by IC3c. The gain of this stage is adjustable by preset VR1, between 1 and 101. Further gain is provided by IC3d, adjustable in the same range by preset VR4. The overall gain is therefore adjustable between 1 and 10201.

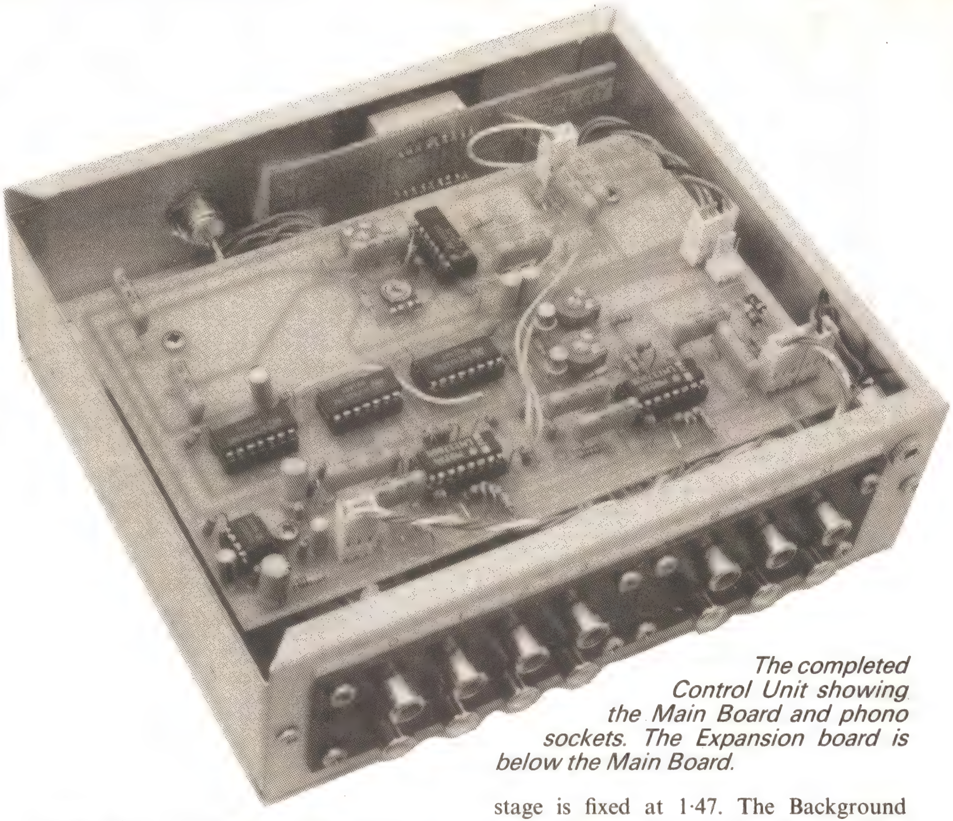
The large and probably clipped analogue signal is converted by IC4a and IC4b to firm pulses to set flip-flop IC5a. These pulses also reset IC6.

While an analogue signal is present, IC5a is continually set and IC6 continually reset, so the Q output of IC5a stays a stable high. When the priority input ceases, no reset pulses are received by IC6, or set pulses by IC5a. IC4c is therefore able to clock the counter up to 9, resetting the flip-flop.

Transistors TR3 and TR4 now toggle, although this is a gentle switching action due to R52/C21, and R53/R54/D6/C22 combination. Preset potentiometers VR2 and VR3 set the maximum current that can bias the VCAs IC1 and IC2, and hence provide adjustable gain.

The VCAs IC1 and IC2 also toggle, in that while one is heading for or is at "high gain", the other is heading for or is at zero gain. Their outputs are mixed and amplified by IC7a, IC7b before being coupled to the output by the combinations of R47/C16 and R48/C17. The gain of this stage is fixed at 1·47. The Background Input passes only to IC1 and then to IC7 in the absence of a "priority" signal.

Next Month: Main Board construction, Expansion board and final interwiring and testing.



The completed Control Unit showing the Main Board and phono sockets. The Expansion board is below the Main Board.

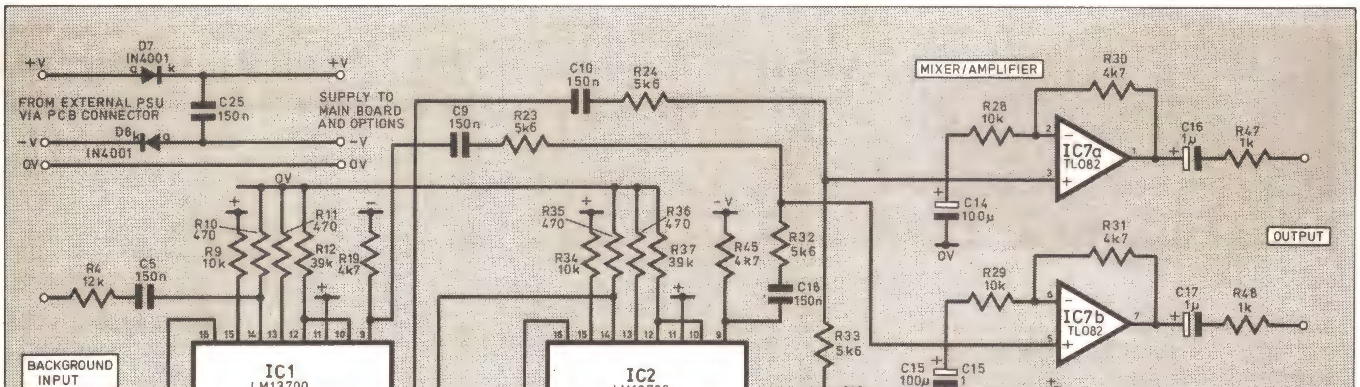


Fig. 9. Full circuit diagram for the Main Control Board.

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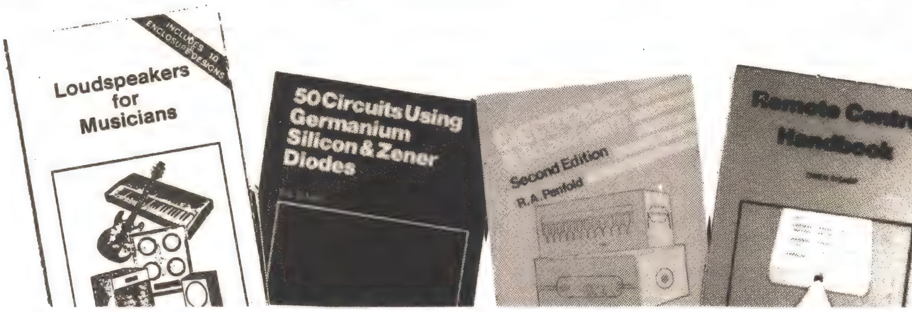
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REPORTING AMATEUR RADIO

Tony Smith G4FAI

REVIEW REPORT PUBLISHED

The report of the Stage 3 Radio Spectrum Review Committee covering 28 to 470MHz was published on 10th March. Set up by the DTI in July 1992, its terms of reference were:

> To examine the current use of the radio frequency spectrum from 28 to 470MHz, making recommendations in the light of developments:
>
> a) in the requirements for both civil and defence radio services, planned or likely to arise within the next ten to fifteen years;
>
> b) in the international arena;
>
> c) in anticipated growth in the use of this part of the spectrum and the technical, operational, regulatory and commercial changes taking place or foreseen.

The Committee makes 28 recommendations which it believes will result in more effective use of the spectrum reviewed. These cover the areas of Defence; Broadcasting; Land Mobile Radio; Fuel, Power and Water Industries; Emergency Services; Other Services; Spectrum Management, and the role of the Radiocommunications Agency. Copies of the report can be obtained from the Radiocommunications Agency Library, telephone 071-215 2150.

Radio amateurs in the UK have five frequency bands in this part of the spectrum and there was naturally some concern about how the review committee would view these allocations.

In the event, amateurs need not have worried. The committee comments "Amateur radio is a popular hobby with about 60,000 licensed operators in the United Kingdom. There are amateur radio allocations, mostly narrow and constrained and, in some cases, shared with other services, around 29, 51, 70, 145 and 435MHz. All or part of the 29, 145 and 435MHz allocations may also be used for accessing amateur satellites. We note the value of amateur radio to the community and propose that, for the foreseeable future, no change should be made to these allocations."

CONSULTATIVE DOCUMENT

Shortly after publication of the report the government published a consultation document *The Future Management of the Radio Spectrum* and proposed to defer responding fully to the Spectrum Review recommendations until the end of the consultation period for the consultative document.

Michael Heseltine, President of the Board of Trade, said "The document seeks views on how to manage the spectrum to maximise the economic benefit derived from it whilst preserving access by the armed forces, the emergency services and the widest range of other users, such as the scientific community and hobbyists. It envisages an extended role for the private sector in planning the spectrum and assigning frequencies, with the Radiocommunications Agency retaining responsibility for a number of core functions that need to be performed by government.

"It also proposes changes to the basis of charging for access to the spectrum to clarify the choices facing radio users. At present, the licence fees paid by radio users give little incentive to use spectrum efficiently. The development of a secondary market in spectrum access rights and selective auctions would enable the value of the spectrum to be better reflected in pricing and make it easier for new users to gain access to spectrum . . . I hope there will now be a wide ranging debate on this important subject. The government will consider how to proceed in the light of the responses to the consultative document."

The document covers a very wide range of radio services and discusses possible changes which could impact greatly on those services. Amateur radio is of course only a small part of the whole, albeit with a distinct and unique place in it. Already, within existing legislation, the distribution of Amateur and CB licences is contracted out by the RA and in the document hobby radio is defined as having the least scope, short of deregulation, for private sector involvement.

However, the question of pricing remains to be settled so the next worry for the amateur community relates to costs. If, as the consultative document suggests, other users should pay more, will amateurs also have to pay increased licence fees?

COMPLAINTS ABOUT SSL

Subscription Services Ltd (SSL) who have the contract for issuing Amateur and CB licences on behalf of the RA are feeling rather sensitive about criticisms levelled at them from users and the media about the way they run their service.

They have also received many complaints about the new renewal procedures which they say are not of their making but were decided on by the Radiocommunications Agency.

Current licence renewal reminders are accompanied by a note describing the changes which, among other things, says "Licence renewal notices will now be sent to licensees six weeks before the annual renewal date of a licence. If payment is not received within those six weeks and a FINAL renewal notice is ignored all details will be cancelled from the computer system.

"Anyone applying to renew late will be treated as a new applicant. An application form will need to be completed and sent with all relevant pass certificates and payment to the Radio Licensing Centre."

In one sense this doesn't seem unreasonable. If people want to keep their licenses current they should pay up in time. However, there are occasions when payment of a bill is overlooked through sickness or some other reason when there is every intention to renew and the problem here is the need to produce relevant pass certificates for late renewals.

As an experiment, I tried to find my own original Radio Amateurs Examination certificate and Morse test pass slip, from over 20 years ago, which I would need for a late renewal. I found them after a long search, but I imagine someone who passed the tests, say, 40 years ago and who couldn't find his certificates might have real difficulty in getting his licence back.

The RA says "We appreciate that some licensees will not have their old certificates and anyone in such a position should be referred to the Agency (by SSL). Applications will then be assessed on a case by case basis depending on what the applicant has been able to supply."

"We require certificates to be re-submitted not because there is no record of the licensee but to encourage people to pay on time. If licensees know they have to re-submit their application with all certificates, they are more likely to renew their licence promptly."

I have invited SSL to let me have a statement about their problems as they see them and will report further when this is received.

In the meantime, to get the full picture, if readers would like to tell me about their own experiences with SSL please write to me c/o the editor.

IOTA'S 30TH BIRTHDAY PARTY

The "Islands on the Air" award programme, which I described in the January 1994 issue, celebrates its 30th birthday this year. The celebrations will be at the RSGB 1994 International HF and IOTA convention at the Beaumont Conference Centre, Old Windsor, Berks, on 7th to 9th of October.

This annual event promises to be even more interesting than usual, with a full programme of at least sixteen different talks on a variety of subjects related to DXpeditions and HF DX operating. On the social side IOTA's birthday party will be on the evening of the 7th, and there will be a DX dinner on the 8th.

The programme will cover IOTA itself, antennas (various talks), computers in the shack, holiday operations from islands, transceivers and the experiences of various DXpeditions, to name but a few. For those wishing to stay the whole weekend, accommodation packages are available, but day visitors are also welcome.

A four page leaflet, with the full programme plus booking form is available from Neville Cheadle G3NUG, "Further Felden", Long Croft Lane, Felden, Hemel Hempstead, Herts HP3 0BN.

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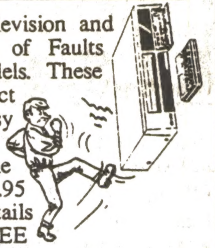

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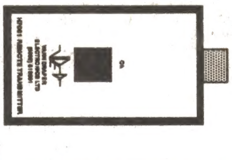

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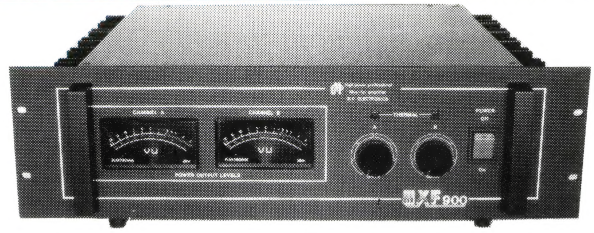

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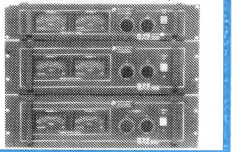

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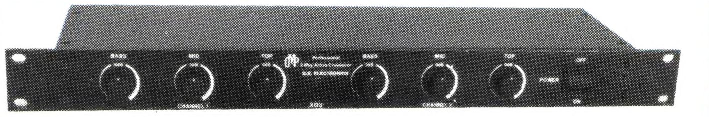
PRICES:- MXF200 £175.00 MXF400 £233.85
MXF600 £329.00 MXF900 £449.15

SPECIALIST CARRIER DEL. £12.50 EACH

OMP XO3 STEREO 3-WAY ACTIVE CROSS-OVER

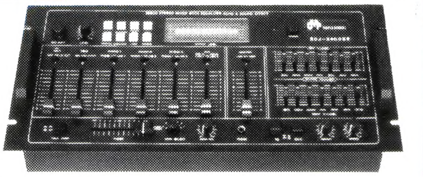


dvanced 3-Way Stereo Active Cross-Over, housed in a 19" x 1U case. Each channel has three level controls: ass, mid & top. The removable front fascia allows access to the programmable DIL switches to adjust the ross-over frequency: Bass-Mid 250/500/800Hz, Mid-Top 1.8/3/5KHz, all at 24dB per octave. Bass invert switches n each bass channel. Nominal 775mV input/output. Fully compatible with OMP rack amplifier and modules.

Price £117.44 + £5.00 P&P

TEREO DISCO MIXER SDJ3400SE ★ ECHO & SOUND EFFECTS★

TEREO DISCO MIXER with 2 x 7 band & R graphic equalisers with bar graph ED Vu meters. **MANY OUTSTANDING EATURES:- including Echo with repeat & peed control, DJ Mic with talk-over witch, 6 Channels with individual faders lus cross fade, Cue Headphone Monitor. 8 ound Effects. Useful combination of the ollowing inputs:- 3 turntables (mag), 3 nics, 5 Line for CD, Tape, Video etc.**

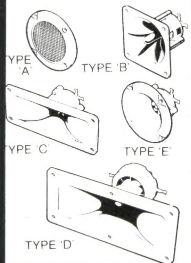


Price £144.99 + £5.00 P&P

SIZE: 482 x 240 x 120mm

IEZO ELECTRIC TWEETERS - MOTOROLA

oin the Piezo revolution! The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved ansient response with a lower distortion level than ordinary dynamic tweeters. As a crossover **is not** required hese units can be added to existing speaker systems of up to 100 watts (more if two are put in series. **FREE XPLANATORY LEAFLETS ARE SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN1036A) 3″ round with protective wire mesh. Ideal for bookshelf and medium sized Hi-Fi apeakers. **Price £4.90 + 50p P&P.**

TYPE 'B' (KSN1005A) 3½″ super horn for general purpose speakers, disco and P.A. systems etc. **Price £5.99 + 50p P&P.**

TYPE 'C' (KSN1016A) 2″x5″ wide dispersion horn for quality Hi-Fi systems and quality discos etc. **Price £6.99 + 50p P&P.**

TYPE 'D' (KSN1025A) 2″x6″ wide dispersion horn. Upper frequency response retained extending down to mid-range (2KHz). Suitable for high quality Hi-Fi systems and quality discos. **Price £9.99 + 50p P&P.**

TYPE 'E' (KSN1038A) 3¾″ horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. **Price £5.99 + 50p P&P.**

LEVEL CONTROL Combines, on a recessed mounting plate, level control and cabinet input jack socket. 85x85mm. **Price £4.10 + 50p P&P.**

bl FLIGHT CASED LOUDSPEAKERS

new range of quality loudspeakers, designed to take advantage of the latest peaker technology and enclosure designs. Both models utilize studio quality 2" cast aluminium loudspeakers with factory fitted grilles, wide dispersion onstant directivity horns, extruded aluminium corner protection and steel all corners, complimented with heavy duty black covering. The enclosures re fitted as standard with top hats for optional loudspeaker stands.

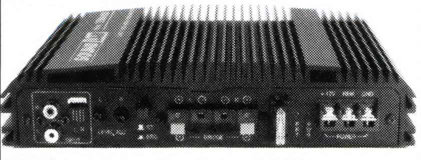
POWER RATINGS QUOTED IN WATTS RMS FOR EACH CABINET
FREQUENCY RESPONSE FULL RANGE 45Hz - 20KHz

***ibl* FC 12-100WATTS (100dB) PRICE £159.00 PER PAIR**
***ibl* FC 12-200WATTS (100dB) PRICE £175.00 PER PAIR**

SPECIALIST CARRIER DEL. £12.50 PER PAIR

OPTIONAL STANDS PRICE PER PAIR £49.00
Delivery £6.00 per pair

N-CAR STEREO BOOSTER AMPS



THREE SUPERB HIGH POWER CAR STEREO BOOSTER AMPLIFIERS

150 WATTS (75 + 75) Stereo, 150W Bridged Mono
250 WATTS (125 + 125) Stereo, 250W Bridged Mono
400 WATTS (200 + 200) Stereo, 400W Bridged Mono

ALL POWERS INTO 4 OHMS

Features:
★ Stereo, bridgable mono ★ Choice of high & low level inputs ★ L & R level controls ★ Remote on-off ★ Speaker & thermal protection.

PRICES: 150W £49.99 250W £99.99
400W £109.95 P&P £2.00 EACH

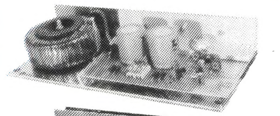
POSTAL CHARGES PER ORDER £1.00 MINIMUM. OFFICIAL ORDERS FROM SCHOOLS, COLLEGES, GOVT. BODIES, PLCs ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA AND ACCESS ACCEPTED BY POST, PHONE OR FAX.

OMP MOS-FET POWER AMPLIFIER MODULES

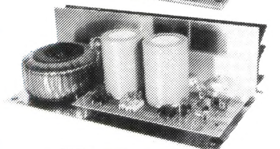
SUPPLIED READY BUILT AND TESTED.

These modules now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models are available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE that all models include toroidal power supply, integral heat sink, glass fibre P.C.B. and drive circuits to power a compatible Vu meter. All models are open and short circuit proof.

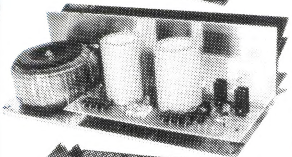
THOUSANDS OF MODULES PURCHASED BY PROFESSIONAL USERS



OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 45V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 123 x 60mm.
PRICE £40.85 + £3.50 P&P



OMP/MF 200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 50V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 300 x 155 x 100mm.
PRICE £64.35 + £4.00 P&P



OMP/MF 300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 60V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB. Size 330 x 175 x 100mm.
PRICE £81.75 + £5.00 P&P

OMP/MF 450 Mos-Fet Output power 450 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.001%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 385 x 210 x 105mm.
PRICE £132.85 + £5.00 P&P

OMP/MF 1000 Mos-Fet Output power 1000 watts R.M.S. into 2 ohms, 725 watts R.M.S. into 4 ohms, frequency response 1Hz - 100KHz -3dB, Damping Factor >300, Slew Rate 75V/uS, T.H.D. typical 0.002%, Input Sensitivity 500mV, S.N.R. -110 dB, Fan Cooled, D.C. Loudspeaker Protection, 2 Second Anti-Thump Delay. Size 422 x 300 x 125mm.
PRICE £259.00 + £12.00 P&P

NOTE: MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS: STANDARD - INPUT SENS 500mV, BAND WIDTH 100KHz. PEC (PROFESSIONAL EQUIPMENT COMPATIBLE) - INPUT SENS 775mV, BAND WIDTH 50KHz. ORDER STANDARD OR PEC.

LOUDSPEAKERS

LARGE SELECTION OF SPECIALIST LOUDSPEAKERS AVAILABLE, INCLUDING CABINET FITTINGS, SPEAKER GRILLES, CROSS-OVERS AND HIGH POWER, HIGH FREQUENCY BULLETS AND HORNS, LARGE (A4) S.A.E. (60p STAMPED) FOR COMPLETE LIST.

McKenzie and Fane Loudspeakers are also available.

EMINENCE:- INSTRUMENTS, P.A., DISCO, ETC

ALL EMINENCE UNITS 8 OHMS IMPEDANCE

8″ 100 WATT R.M.S. ME8-100 GEN. PURPOSE, LEAD GUITAR, EXCELLENT MID, DISCO.
RES. FREQ. 72Hz, FREQ. RESP. TO 4KHz, SENS 97dB. **PRICE £32.71 + £2.00 P&P**

10″ 100 WATT R.M.S. ME10-100 GUITAR, VOCAL, KEYBOARD, DISCO, EXCELLENT MID.
RES. FREQ. 71Hz, FREQ. RESP. TO 7KHz, SENS97dB. **PRICE £33.74 + £2.50 P&P**

10″ 200 WATT R.M.S. ME10-200 GUITAR, KEYB'D, DISCO, VOCAL, EXCELLENT HIGH POWER MID.
RES. FREQ. 65Hz, FREQ. RESP. TO 3.5KHz, SENS 99dB. **PRICE £43.47 + £2.50 P&P**

12″ 100 WATT R.M.S. ME12-100LE GEN. PURPOSE, LEAD GUITAR, DISCO, STAGE MONITOR.
RES.FREQ. 49Hz, FREQ. RESP. TO 6KHz, SENS 100dB. **PRICE £35.64 + £3.50 P&P**

12″ 100 WATT R.M.S. ME12-100LT (TWIN CONE) WIDE RESPONSE, P.A., VOCAL, STAGE MONITOR. RES. FREQ 42Hz, FREQ. RESP. TO 10KHz, SENS 98dB. **PRICE £36.67 + £3.50 P&P**

12″ 200 WATT R.M.S. ME12-200 GEN. PURPOSE, GUITAR, DISCO, VOCAL, EXCELLENT MID.
RES. FREQ. 58Hz, FREQ. RESP. TO 6KHz, SENS 98dB. **PRICE £46.71 + £3.50 P&P**

12″ 300 WATT R.M.S ME12-300GP HIGH POWER BASS, LEAD GUITAR, KEYBOARD, DISCO ETC.
RES. FREQ. 47Hz, FREQ. RESP. TO 5KHz, SENS 103dB. **PRICE £70.19 + £3.50 P&P**

15″ 200 WATT R.M.S. ME15-200 GEN. PURPOSE BASS, INCLUDING BASS GUITAR.
RES. FREQ. 46Hz, FREQ. RESP. TO 5KHz, SENS 99dB. **PRICE £50.72 + £4.00 P&P**

15″ 300 WATT R.M.S. ME15-300 HIGH POWER BASS, INCLUDING BASS GUITAR.
RES. FREQ. 39Hz, FREQ. RESP. TO 3KHz, SENS 103dB. **PRICE £73.34 + £4.00 P&P**

EARBENDERS:- HI-FI, STUDIO, IN-CAR, ETC

ALL EARBENDER UNITS 8 OHMS (Except EB8-50 & EB10-50 which are dual impedance tapped @ 4 & 8 ohm)

BASS, SINGLE CONE, HIGH COMPLIANCE, ROLLED SURROUND

8″ 50watt EB8-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 7KHz SENS 97dB. **PRICE £8.90 + £2.00 P&P**

10″ 50WATT EB10-50 DUAL IMPEDENCE, TAPPED 4/8 OHM BASS, HI-FI, IN-CAR.
RES. FREQ. 40Hz, FREQ. RESP. TO 5KHz, SENS. 99dB. **PRICE £13.65 + £2.50 P&P**

10″ 100WATT EB10-100 BASS, HI-FI, STUDIO.
RES. FREQ. 35Hz, FREQ. RESP. TO 3KHz, SENS 96dB. **PRICE £30.39 + £3.50 P&P**

12″ 100WATT EB12-100 BASS, STUDIO, HI-FI, EXCELLENT DISCO.
RES. FREQ. 26Hz, FREQ. RESP. TO 3 KHz, SENS 93dB. **PRICE £42.12 + £3.50 P&P**

FULL RANGE TWIN CONE, HIGH COMPLIANCE, ROLLED SURROUND

5¼″ 60WATT EB5-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 63Hz, FREQ. RESP. TO 20KHz, SENS 92dB. **PRICE £9.99 + £1.50 P&P**

6½″ 60WATT EB6-60TC (TWIN CONE) HI-FI, MULTI-ARRAY DISCO ETC.
RES. FREQ. 38Hz, FREQ. RESP. TO 20KHz, SENS 94dB. **PRICE £10.99 + 1.50 P&P**

8″ 60WATT EB8-60TC (TWIN CONE) HI-FI, MILTI-ARRAY DISCO ETC.
RES. FREQ. 40Hz, FREQ. RESP. TO 18KHz, SENS 89dB. **PRICE £12.99 + £1.50 P&P**

10″ 60WATT EB10-60TC (TWIN CONE) HI-FI, MULTI ARRAY DISCO ETC.
RES. FREQ. 35Hz, FREQ. RESP. TO 12KHz, SENS 98dB. **PRICE £16.49 + £2.00 P&P**

TRANSMITTER HOBBY KITS

PROVEN TRANSMITTER DESIGNS INCLUDING GLASS FIBRE PRINTED CIRCUIT BOARD AND HIGH QUALITY COMPONENTS COMPLETE WITH CIRCUIT AND INSTRUCTIONS

3W TRANSMITTER 80-108MHz, VARICAP CONTROLLED PROFESSIONAL PERFORMANCE, RANGE UP TO 3 MILES, SIZE 38 x 123mm, SUPPLY 12V @ 0.5AMP.
PRICE £14.85 + £1.00 P&P

FM MICRO TRANSMITTER 100-108MHz, VARICAP TUNED, COMPLETE WITH VERY SENS FET MIC, RANGE 100-300m, SIZE 56 x 46mm, SUPPLY 9V BATTERY.
PRICE £8.80 + £1.00 P&P

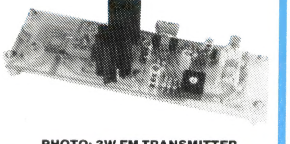


PHOTO: 3W FM TRANSMITTER

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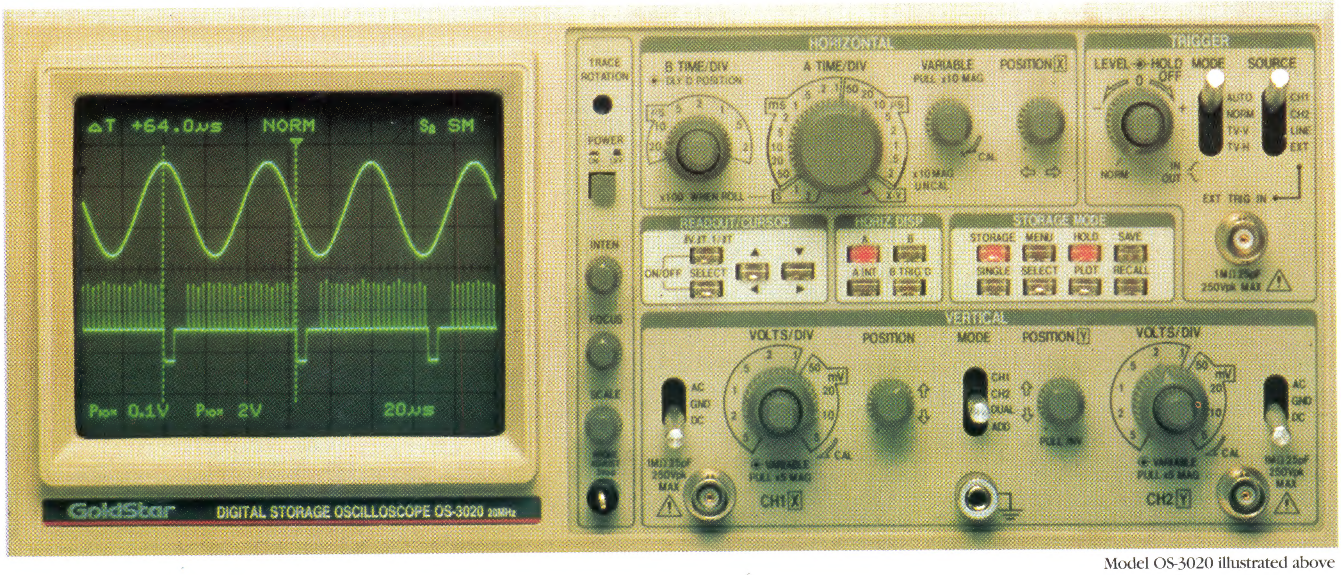

Model OS-3020 illustrated above

Star Quality, Reliability, and World Class Performance

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NEW Maplin Electronics are pleased to announce their superb new range of precision, laboratory grade Oscilloscopes from Goldstar.

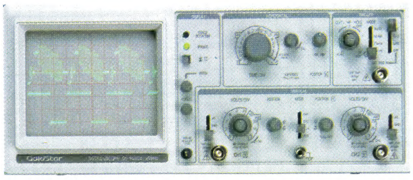
NEW The range starts with the super value-for-money, 20MHz Dual-trace Oscilloscope, OS-9020A. Features include a large 6in., high luminance CRT with internal 8 x 10cm graticule, TV field or line triggering and X-Y mode producing Lissajous patterns for phase shift measurements.

NEW For higher frequency applications, the 40MHz Dual-trace Oscilloscope, OS-9040D, is ideal for TV and video signals and a trigger delay facility allows observation of fast leading edges.

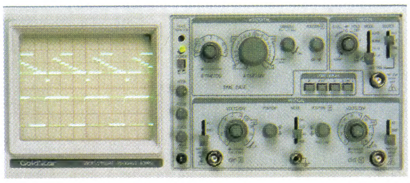
NEW For RF signals and high-speed logic applications, the highly specified 100MHz triple-trace Oscilloscope, OS-9100D, has 3 independent input channels and is ideal for simultaneous display of 3 logic pulse trains for timing comparison.

NEW The dual-trace, 40MHz Oscilloscope, OS-904RD, is similar in specification to OS-9040D, but with the additional facility of a digital readout on the CRT. The readout displays information such as timebase and attenuator settings, and on-screen measurements can be performed using movable cursors, the value appearing on the CRT screen.

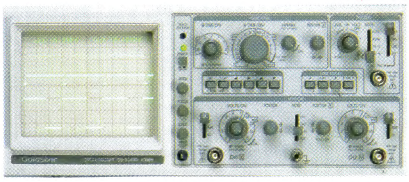
NEW Top-of-the-range is the excellent 20MHz Digital Storage Oscilloscope, OS-3020, with on-screen digital read-out and measurement facilities. The digital storage function enables one-off events to be captured and stored for detailed analysis. Stored waveforms can be printed out on a suitable X-Y plotter via the built-in RS232 interface. Repetitive high-speed waveforms up to 20MHz can be digitised using equivalent sampling techniques and pre-trigger mode allows events occurring before the triggering point to be captured.



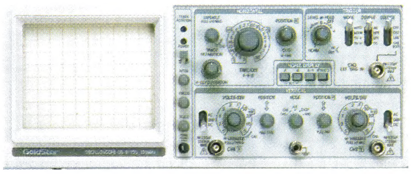
OS-9020A GW03D **£269.95**



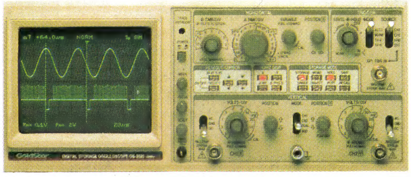
OS-9040D GW04E **£399.95**



OS-904RD GW06G **£499.95**



OS-9100D GW05F **£699.95**



OS-3020 GW07H **£749.95**

All models are supplied complete with probes, mains lead, spare fuses and detailed operating manual. Full details and specifications can be found in the **1994 Maplin Full Colour Catalogue**, available from **WHSMITH** and selected branches of **RSMcColl** in Scotland for £2.95 (£3.45 by post direct from Maplin). To order, Phone the Credit Card Hotline, 0702 554161, or send your Mail Order to P.O Box 3, Rayleigh, SS6 2BR, or visit your local Maplin store. Please note latest models all now cream in colour as Model OS-3020.

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